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State-of-Art, Sugarbeet Processing

Waste Treatment

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16. Abstract

The United States beet sugar industry produces annually in excess of 3 million tons of sugar from about 25 million tons of beets grown in 19 states. Discharge of wastes has dropped from 30 to 40 lbs BOD/ton of beets sliced to 3.15 lbs BOD/ton of beets sliced, but the total annual discharge is still 79 million pounds of BOD. 58 beet sugar factories operating in 1968-69 were studied as to waste disposal practices, amounts of water used, and water re-use practices. Main water usages are flume or transport water (2340 gal/ton of beets processed), process water (270 gal/ton of beets processed), lime mud (50 gal/ton processed), condenser water, Steffan dilution water, and miscellaneous other uses. Sedimentation ponds and clarifiers are the most widely used solids separation processes, but much of the waste disposal problem is eliminated by recycling, to the extent that several of the plants studied had no effluent BOD discharges. No average waste treatment costs for the industry were presented, since such costs are subject to such a wide plant to plant variation. Needed research is outlined, and a brief description of the entire beet sugar process is presented. Current practices in several Western European countries are also presented. (Lowry-Texas)

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Abstractor Mark V. Lowry
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ABSTRACT

The beet sugar industry in the United States produces annually more than 3 million tons of sugar from about 25 million tons of beets grown in 19 states. This paper reports the waste disposal practices of the 58 beet sugar factories operating in 1968-69 and provides an estimate of the amount of pollution of streams attributable to these factories. It is shown that, although stream pollution has been greatly reduced, the beet industry still discharges to streams 3.15 pounds BOD per ton of beets sliced or a total of about 79 million pounds annually. Amounts of water used are reported and methods of re-use of water described. Estimates of total settleable solids are made; methods of elimination are described. Effectiveness of some biological treatments are estimated. Needed research is briefly outlined. Costs of waste disposal facilities and annual operating costs are shown for many of the plants. A brief description of the beet sugar process is furnished. Current practices employed by a selected group of sugarbeet processing plants in several Western European countries are also described.

This report was submitted in fulfillment of Grant #12060 DSI under the sponsorship of the Water Quality Office, Environmental Protection Agency.

Key words: Sugarbeet waste treatment, state-of-art, BOD discharge, water consumption, water re-use, treatment costs.

CONTENTS

Section Page

I Conclusions 1
II Recommendations 3
III Introduction 5
IV Manufacturing Process 7
V Water Use in the Beet Sugar Factory 13
  Flume or Transport Water 13
  Process Water 13
  Lime Mud 14
  Barometric Condenser Water 14
  Steffen Dilution Water 15
  Miscellaneous Water Uses 16
VI Flow Diagrams 17
VII Waste Treatment and Disposal 21
  Flume Water 21
  Barometric Condenser Water 22
  Lime Mud 22
  Steffen Waste 23
  General Wastes 24
VIII Associated Waste Disposal Problems 25
IX Treatment and Discharge of Effluents 27
X Cost of Waste Disposal Facilities 31
XI Laboratory and Pilot Plant Work on Waste Treatment 33
XII Problems Requiring Additional Research and Development 37
XIII Discussion 39
XIV References 43
XV Glossary 51
XVI Appendices 53

FIGURES

No.		Page
1.	Type I Water Flow in Beet Sugar Factory	18
2.	Type II Water Flow in Beet Sugar Factory	18
3.	Type III Water Flow in Beet Sugar Factory	19
4.	Type IV Water Flow in Beet Sugar Factory	20
5.	Waste Water Scheme - Ameln Factory (Pfeiffer and Langen)	56
6.	Schladen Factory Waste Water Scheme	58
7.	Wabern Factory Water Scheme	60
8.	Biological Filter Flow for Effluent Treatment, Ely Factory	64
9.	Newark Factory Waste Water Scheme	65
10.	Wissington Factory Passveer Oxidation Ditch	66
11.	Waste Water Scheme, Örtofta	73
12.	Aarberg Factory Water Scheme	74

TABLES

Page

1. Present and Projected Processing Capacity of Beet Sugar Factories by States 7
2. The Average Raw Material Requirements and End Products Produced Per Ton of Beets Processed 10
3. Water Characteristics of the Schladen Factory (Germany) 59
4. Water Characteristics of the Wabern Factory (Germany) 61
5. Water Characteristics of the Ely Factory (Great Britain) 63
6. Water Characteristics of the Newark Factory (Great Britain) 66
7. Water Characteristics of the Breda Factory (Netherlands) 68
8. Water Characteristics of the Örtofta Factory (Sweden) 72
9. Summary of Factory Capacities and Fresh Water Usage 78
10. Water Use and Re-Use Per Ton Beets 83
11. Waste Discharged to Stream Per Ton of Beets; Cost of Disposal Facilities 88
12. Beet Sugar Factories Included in This Survey 91

Water Use, Re-Use and Disposal (by Factories) 94

SECTION I

CONCLUSIONS

The successful production of sugar from sugarbeets dates from about 1870. Many of the original factories were constructed at sites near small agricultural communities. The growth of these communities has required the installation of waste treatment, and/or water conserving systems to remain a welcome partner of each area's economic structure. The early-day discharge to receiving waters of between 30 to 40 pounds of BOD_5 per ton of beets processed has been reduced to an average of 3.15 pounds in 1968. Greatest advancements have taken place in the last 10 years; a number of factories now recycle much of the process waters. Some factories do not discharge BOD-containing water.

The technology presently known on the treatment and handling of sugarbeet process wastes does not provide a single scheme that is applicable to each and all geographical areas. It has been noted that each factory is undergoing constant improvement by periodic additions to existing facilities. The need to reduce or eliminate the discharge of process waters from the factory premises is recognized by the industry and will be accomplished as technology and time permit. The progressive development of local and national water quality standards will influence priority schedules for the upgrading of treatment systems.

SECTION II

RECOMMENDATIONS

Under the structure of the Federal Sugar Act, the price of sugar to consumers is controlled through the powers vested in the Secretary of Agriculture. Periodically each year he amends the total national consumption requirements. Sales quotas to domestic producers are adjusted accordingly. This unique method whereby price of product is controlled, precludes the potential of translating waste treatment costs to the end product price. This fact modifies the recommendation of some typical waste treatment systems. It has been demonstrated, however, that beet wastes are generally amenable to presently-known treatment practices. It would appear that appropriate treatment techniques to each separate stream offers considerable promise for the future. Otherwise, surge or mixing lagoons to produce a more uniform waste would provide a waste that can be digested by either aerobic or anaerobic organisms. Due to odor problems associated with anaerobic digestion, aerobic approaches should be given preferable attention. The handling and treatment of waste lime mud and precipitated flume water solids need additional research efforts. The land available for discard of these wastes becomes less and less. The by-product use of these solids should be explored.

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SECTION III

INTRODUCTION

Under the terms of an agreement with the Federal Water Quality Administration, this report presents data relating to the domestic and foreign waste treatment technology in the sugarbeet processing industry and outlines areas requiring further development. This report includes:
(a) projections of the potential growth of the domestic industry and its water pollution problems over the next ten years; (b) details of present treatment practices including hydraulic and organic loads, plant sizes, removal efficiencies, construction and operating costs; (c) a discussion of pilot plant work on waste treatment; and (d) an analysis of the manufacturing process with a view toward further in-plant treatment, by-product recovery and water re-use.

The reporting of data on a comparable basis has been complicated by the diversity of conditions under which the 58 sugarbeet processing plants operate. Sugar-processing plants are located from the near-tropical areas of southern California and Arizona to the frigid areas of Montana, Minnesota and North Dakota; from the arid or semi-arid regions of the west to the areas of more abundant rainfall in the east.

Of the 10 million tons of sugar consumed during 1968 in the United States, more than three million tons were produced from sugarbeets. The remainder was produced from mainland cane or supplied from imported cane raws.

SECTION IV

MANUFACTURING PROCESS

The slicing capacity of the factories shown in Table 1 ranges from a low of 1,275 to a high of 7,000 tons per day, averaging about 3,250 tons each. Of these factories, 21 also recover sugar from molasses by the Steffen process and one uses an ion-exchange process. One company produces sugar from discard beet molasses by a barium process in a separate plant and recovers monosodium glutamate from Steffen and barium saccharate filtrates in still another plant. All factories in this country and abroad use basically the same processes. Differences in fresh water use and re-use and in waste loads result from differences in operating practices and, to a minor degree, from differences in equipment. Facilities for handling wastes vary markedly from plant to plant. It will be noted that the quantity of fresh water taken into plants in different areas varies greatly. The total water, including re-used water, varies much less. Most of the water used in a sugarbeet processing plant is used for condensing vapors from evaporators and pans and for conveying and washing beets. These uses do not require water of high purity, hence considerable recirculation is possible. Differences in fresh water use and in recirculation practices affect the quantity of wastes discharged from the plant.

Table 1. Present and Projected Processing Capacity of Beet-sugar Factories by States.

State	Number of Factories	Rated Capacity (1968) Tons beet/day	Actual Capacity (1968) Tons beet/day	Projected Capacity Within 10 yrs.
California	10	39,800	37,825	40,000
Colorado	10	25,400	26,500	29,300
Michigan	5	10,900	10,324	11,800
Idaho	4	20,000	20,169	24,950
Minnesota	4	12,800	11,830	14,750
Nebraska	4	9,510	9,974	10,000
Montana	3	8,720	8,450	11,450
Ohio	3	5,000	5,130	5,130
Utah	3	6,350	5,972	6,350
Wyoming	3	7,200	6,817	7,550
Washington	2	10,525	10,250	13,800
Arizona	1	4,200	4,200	4,200
Iowa	1	2,400	1,881	2,400
Kansas	1	3,200	2,605	3,600
Maine	1	4,000	4,000	4,000
North Dakota	1	5,000	3,915	5,000
Oregon	1	6,650	6,600	7,200
Texas	1	6,500	6,500	6,500
Totals	58	188,155	182,942	207,980

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A knowledge of the sugar production process is essential to an understanding of the waste disposal problem. A brief description of the process is provided in sufficient detail to show the approximate quantities of operating materials and supplies, the yields of salable products and the magnitude of wastes discharged.

The sugar company exercises considerable control of the sugarbeets long before they are delivered to the factory. It obtains acreage allotments[1], develops or selects seed best suited to the area, makes contracts with growers for the proper growing, harvesting, and delivery of the beets to the factory or to the receiving stations. It determines when the harvest will commence and, usually, the rate of harvest--the latter being determined in some instances by the receiving equipment available and in others, where storage of beets in piles is impractical, by the slicing capacity of the plant. Beets in the northern interior sections of the United States are processed in the fall from late September or early October to January or even later. In these areas beets are stored in large piles. Harvesting must be completed before freezing weather sets in. The harvest in these areas is usually completed early in November, although some beets may not be dug until considerably later. The processing period is considerably longer than the period of harvest, hence beets must be kept in open storage for periods ranging from 20 to 40 or more days during which time considerable deterioration occurs.

In California and other areas where warmer winter temperatures prevail, storage of beets in piles is not feasible. The harvest is carefully regulated in these regions so that beets may be processed soon after removal from the field. In some of these areas the harvesting may be interrupted by winter rains. The plants are closed until the rainy season ends and harvesting can begin again.

Loss of sugar from beets in storage is serious even under the best of conditions; therefore, great effort is made to reduce the time in storage by maintaining maximum slicing rates in the factories even at some sacrifice in extraction efficiency.

Beets are delivered to the factory by trucks or railroad cars and stored in large piles or dumped directly into flumes for transport into the processing plant. The flumes are steel or concrete-lined channels through which beets are conveyed by a continuous stream of water.

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[1] Acreage allotments are imposed upon growers by the Federal Government for certain years when over-production is to be avoided. Thus, eventual marketing of sugar from sugarbeets meets the limits established by the terms of the Sugar Act.

Water for the flumes is supplied from the main fresh water tank or from the evaporator and pan barometric condenser seal tanks. The flumes are provided with rock catchers which trap and remove stones and other heavy foreign material from the flow of beets. Trash catchers remove light material including weeds and loose beet tops. The beets are lifted from the flume to a beet washer by a beet wheel. They are discharged from the washer to a roller conveyor where a final washing is given by means of sprays of clean water under high pressure. The washed beets are elevated to the slicer station where they are sliced into thin strips called cossettes and fed into a continuous diffuser. A mechanism is usually installed in a section of the belt feeding the diffuser to weigh the beets entering the process. Washings from the beet washer and sprays are discharged into the flume. As will be noted later, this flume water constitutes the largest volume of waste and, because of its volume and high content of suspended and dissolved solids, becomes one of the most difficult to handle.

The diffuser is the first step in the beet sugar process. It extracts sugar and other soluble solids from the cossettes under a countercurrent flow of water. The liquor containing the sugar and other soluble solids--called "raw juice"-- is drawn off the diffuser and pumped to the purification stations.

The exhausted cossettes are usually conveyed to pulp presses which reduce the water content of the pulp to about 80 percent before the cossettes are fed into a pulp drier. The pulp press water is usually returned to the diffuser as part of the diffuser supply. A very few plants do not dry the pulp. The wet pulp in these cases is pumped over a screen to separate the pulp from the transport water. The pulp is then discharged to a silo. Drainage from the wet pulp silo constitutes one of the main sources of BOD in the plant effluent. A particularly objectionable feature of the pulp silo is the prolonged period of drainage, often continuing for months after completion of the beet processing campaign.

The juice from the diffuser containing most of the sugar from the beets, as well as soluble and colloidal impurities, is pumped to the first carbonation station. Lime in the form of a slurry of calcium hydroxide or calcium saccharate (from the Steffen process) is added and the mixture is gassed with carbon dioxide from the lime kiln to precipitate the lime. The calcium carbonate thus formed carries with it suspended impurities in the juice. The lime precipitate is separated from the mixture by means of thickeners and filters, and then is pumped to a waste pond. The thin juice, after further treatment with CO_2, filtration and treatment with sulfur dioxide to reduce the pH to about 8, is concentrated in multiple-effect evaporators to a thick (65 percent solids) juice and then boiled in a single-effect evaporator (pan) to crystallize sugar. The sugar is separated by centrifugation from the adhering syrup and dried. The syrup is concentrated further to yield additional crystalline sugar and finally, molasses.

The molasses may be sold as such for animal feed or other purposes or may be desugarized by the Steffen process. In this process the molasses is diluted, cooled and treated with powdered quick lime to precipitate the sugar as a saccharate.

The calcium saccharate after separation by filtration from the solution of molasses impurities is pumped to first carbonation. The Steffen filtrate may be discharged as a waste or, after precipitation and removal of calcium carbonate, evaporated to a thick liquor called concentrated Steffen filtrate and dried on beet pulp or used as a source for salable by-products--monosodium glutamate, potash fertilizer salts and animal feed.

The raw materials entering the beet sugar process are beets, limestone, small amounts of sulfur, fuel and water. The products are refined sugar, dried beet pulp and molasses (See Table 2). The latter, as indicated previously, may be further processed to yield additional sugar.

Table 2. The Average Raw Material Requirements and End Products Produced Per Ton of Clean Beets Processed.

Limestone, tons	0.04
Fuel, coal or gas, BTU	2.5×10^6
Water, intake, gal.	2200
Beet pulp, dry, tons	0.05
Sugar produced, tons	0.13
Molasses, tons	0.05
Waste water, gal.	2100
at Steffen Factories	
Molasses worked, tons	0.05
Additional limestone, tons	0.02
Additional sugar produced, tons	0.015
Steffen filtrate, gal.	90

Wide differences in these quantities are experienced at individual factories, particularly with regard to fresh water intake. Eight factories withdraw less than 900 gallons per ton of beets sliced (one, only 215) while eight withdraw 4,000 gallons or more.

Within the last 2 decades, two important equipment changes have been made in United States beet sugar factories which have affected water usage and quantities of wastes. These are the installations of continuous diffusers and of pulp driers. Although the first continuous diffuser was installed more than 30 years ago, replacement of the Roberts (cell-type) diffuser in the United States beet sugar industry was not completed until two years ago. The first pulp drier was installed in an American factory over 50 years ago; one factory is still without one.

The continuous diffuser permits factories to operate with lower draft, i.e., with lower quantities of diffuser supply water. A further marked reduction in water required for the diffusion process is accomplished by the return of pulp press water to the diffuser. With the Roberts diffuser pulp water and pulp press water were discharged as a waste.

The greatest reduction in fresh water usage, however, has been accomplished by the recirculation of flume water and by the re-use, after cooling, of condenser water. Incentive for these changes has been: first, the necessity, in some areas, for conserving the limited sources of fresh water; and second, the advantages of reducing the volume of wastes to permit use of smaller ponds and other waste treatment facilities.

SECTION V

WATER USE IN THE BEET SUGAR FACTORY

Water is used for six principal purposes: (a) transporting (fluming) and washing of beets, (b) processing, i.e., extraction of sugar from beets, (c) transporting solid wastes--lime cake, (d) condensing vapors from evaporators and pans and cooling, (e) at Steffen factories, dilution of molasses, and (f) cleaning of equipment and plant. A brief description of each usage follows:

Flume or Transport Water

Transport of beets from piles or cars into the factory is invariably accomplished by means of water flowing in a narrow channel (flume) which not only provides gentle handling of the fragile beets but removes much adhering soil. Beets are lifted from the flume to a washer and then subjected to a final wash by sprays. The combined flume, washer and spray water constitutes the largest single usage of water, ranging from 1,200 to 4,000 gallons per ton of beets, averaging about 2,340. This is not necessarily all new water. In most factories flume water is recycled, usually after separation of much of the suspended soil. The flume water carries in addition to suspended matter, dissolved solids extracted from the beets. The amount extracted depends largely on the condition of the beets.

Water used for fluming in many factories is water drawn from the barometric condenser seal tanks. In others fresh water is used, either alone or as a supplement to condenser water. The use of warm condenser seal tank water for fluming is necessary in cold climates to thaw frozen beets.

Process Water

Process water is used to extract sugar from the beet. About 270 gallons of water per ton of beets is used for this purpose. Data submitted indicate in some instances, considerably more but these probably include some pulp transport water. Nearly all factories report 100 percent recycle of pulp water and pulp press water. The weight of juice drawn from the diffuser amounts to about 125 percent of the weight of beets entering. The pressed pulp contains about 80 percent moisture. It is easily calculated that make-up water to the diffuser must be at least 45 percent of the weight of beets. The total diffuser supply water consisting of make-up and recycle will therefore range from about 100 to 120 percent of the entering weight of beets, or equivalent to 240 to 290 gallons per ton of beets. The make-up water may be drawn from fresh water supplies, barometric condenser water, condensed water from the heaters, or a combination of these sources. Where condenser waters are cooled and re-used a build-up of dissolved solids may result, rendering its use in the diffuser undesirable.

Two factories of the Holly Sugar Corporation do not recycle pulp water and pulp press water. The Torrington factory has no pulp drier. Condenser water is used as the sole source of diffuser supply. Pulp water and pulp silo drainage containing large amounts of organic matter are discharged as wastes. The Brawley factory has a pulp drier but does not recycle the pulp water or pulp press water back to the diffuser. Instead, these waters are discharged to waste ponds. Both fresh water and condenser water are used as diffuser supply.

The Union Sugar Company factory at Betteravia, California also uses fresh or condenser water as diffuser supply with no recycle of pulp press water.

Lime Mud

The precipitate of calcium carbonate containing raw juice impurities is removed by a rotary vacuum filter which discharges a cake containing about 50 percent water. It is slurried with water and pumped to a lime pond. Water used to slurry the lime cake may be fresh water, condenser water or other in-house hot water. It is desirable to use minimum amounts of water to avoid filling and overflowing the lime ponds. The quantities actually used vary from less than ten gallons per ton of beets to more than 100. Most of the factories use 20 to 60, averaging about 50 gallons per ton of beets. A. Carruthers, reporting on European practices in this regard, (See appendix) describes a factory in Switzerland which adds only a small amount of water to the cake and transports it to a distant pond with compressed air. American practice has tended, in recent years, toward reduced use of water in the lime mud slurry. The lime mud, though relatively small in volume, is high in BOD and suspended solids.

Barometric Condenser Water

Cold water in large quantities is required for use in the barometric condensers of the evaporators and pans. The quality of the water is not important but since the only source of cold water is the fresh water from wells or streams it is usually relatively pure. In 20 of the 58 factories in the United States, condenser water is cooled by cooling towers or spray ponds and recycled to the condensers.

In 38 of the United States beet sugar factories, spent condenser water frequently is re-used, principally for fluming beets. In many of these, condenser water is the only source of flume water.

The amount of condenser water used varies from 1,300 to 4,500 gal/ton beets. The average usage is 2,210 gallons per ton of beets sliced.

In factories where recycling of flume water is practiced, it is often advantageous to discharge the condenser water direct to streams. By this expedient a large volume of effluent containing relatively little BOD by-passes the waste ponds. The BOD in spent condenser water, however, is not negligible; often amounting to 0.5 pounds per ton of beets. Usually the temperature is about 50° C and the dissolved oxygen content near zero; hence discharge into small-flow streams sometimes results in the killing of fish. Twenty-six of the 38 factories that do not recycle condenser water now discharge all or a considerable part of condenser waters direct to streams.

Steffen Dilution Water

Twenty-one beet sugar factories employ the Steffen process. In this process, molasses containing about 50 percent sucrose is diluted with cold fresh water to produce a "solution-for-cooler" containing 5 to 6 percent sucrose. At the six Steffen factories of the Great Western Sugar Company about 45 percent of the dilution water is replaced by Steffen waste.

Steffen waste is concentrated at fourteen factories. The concentrate (CSF) is mixed with extracted pressed beet pulp and dried. At the other seven Steffen factories, the Steffen waste is discharged to shallow ponds where it dries or is lost by seepage.

At the Hamilton City factory of the Holly Sugar Corporation, an ion-exchange process is used for treating about 75 percent of the syrup centrifuged from second boiling fillmass, a mixture of mother liquor and sugar crystals. Regeneration of the ion-exchange resin columns with acid and with ammonium hydroxide produces wastes somewhat similar to Steffen waste. Raw water is used for dilution of syrups in this process and for the regeneration and washing of the columns. The wastes are separated into two main streams, one of which is dried on pulp, the other concentrated to produce a nitrogenous fertilizer product. There is no discharge to streams.

Another special case is the Johnstown molasses plant where molasses is desugarized by a barium hydroxide process. This operation will be discussed in greater detail later but it is to be noted that a waste similar to Steffen waste is produced. It, too, is concentrated and subsequently used as additive to beet pulp.

Miscellaneous Water Uses

Heating and evaporation of juices by steam or vapors result in the production of quantities of condensed waters ranging from 150 to 200 percent of the weight of beets sliced. The purest of these condensates are collected and used as boiler feed. Normally, no other water is used for this purpose. Condensed waters are used for many other purposes: diffuser supply (in part), press wash, i.e., washing of lime cake precipitate, centrifugal wash, house hot water (cleaning evaporators, floors, etc.). Some of the cleaning operations require the use of acids or caustic soda. The wastes are sent to the main sewer and general ponds. The flow is intermittent and often results in sudden changes in the pH of the effluent to ponds. This accounts, in part, for erratic behavior of waste treatment processes.

SECTION VI

FLOW DIAGRAMS

Water uses, re-uses, and disposal vary greatly among the factories, but may be represented, in general, by the four flow diagrams shown in Figures 1 to 4. Actually, these four flow diagrams do not represent, exactly, the water and material flow in any particular factory but they illustrate four general types of flow. It is not practical to show in detail all the modifications exhibited by individual plants. The arrangements, volumes, and depths of settling ponds and of waste storage ponds vary greatly among factories.

Type I (Figure 1) represents a water flow once very common in the United States beet sugar industry but now found only at one plant--Torrington, Wyoming. Even at this plant, there is some modification. The type is characterized by the absence of re-use of water in the plant except for some limited use of condenser water in the beet flumes. This diagram illustrates the extreme usage of raw water in a beet processing plant and has been included to show the progress in water re-use during the past several years.

Type II (Figure 2) represents a water flow now very common in the industry. In this type all the fresh water is used in the barometric condensers of evaporators and pans, for miscellaneous cooling, and at Steffen factories for dilution of molasses. Spent condenser water is used for fluming and washing beets, for make-up water in the diffuser and for other purposes. Factories employing this type of water-flow are equipped with continuous diffusers, pulp screens, pulp presses, and pulp driers. Pulp press water is returned to the diffuser. Settling ponds for removing soil from spent flume water and ponds for collecting lime mud are provided. The overflow from ponds and any excess condenser water is discharged to streams. Thirty-one factories use this pattern of water flow.

Type III (Figure 3) represents a flow pattern involving more complete re-use of water. Fresh water, as in Type II, is used only in evaporator and pan condensers; for some miscellaneous cooling and at Steffen factories for dilution of molasses. During campaign, flume water after screening is pumped to settling ponds and, after more or less complete removal of settleable solids, is returned to the flumes. Water from the evaporator and pan barometric condensers is used as make-up water in the diffuser and in the beet washers and sprays. Pulp water and pulp press water are returned to the diffuser. Lime mud is pumped to a separate lime pond; the overflow, if any, is discharged to the stream. Most of the condenser water is cooled by cooling tower or spray pond and recycled to condensers. Steffen waste is evaporated to concentrated Steffen filtrate. Twenty-three factories use this pattern of water flow with some modifications.

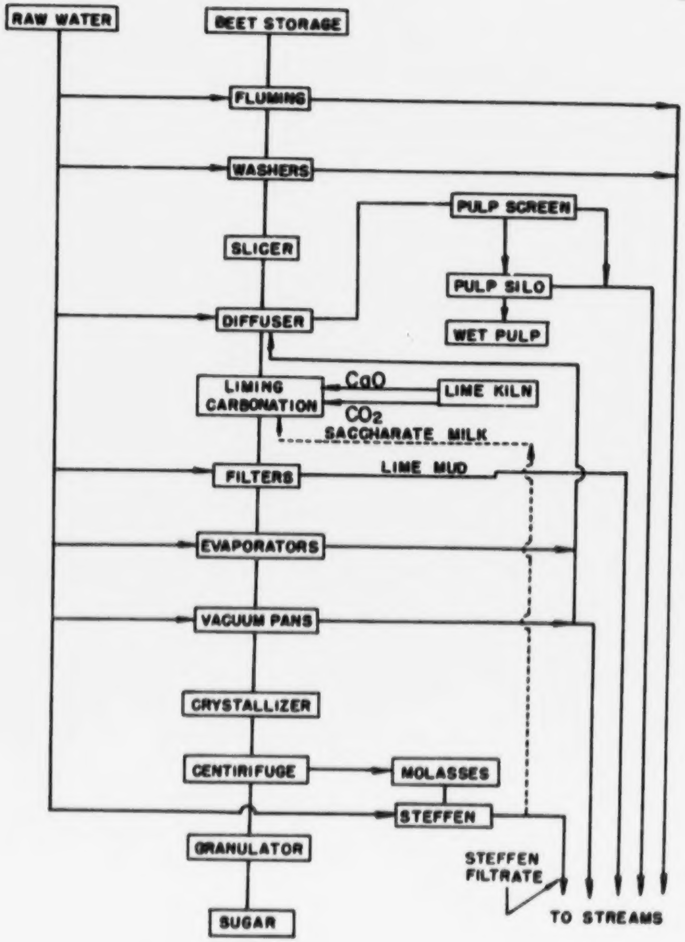
RAW WATER
BEET STORAGE
FLUMING
WASHERS
SLICER
DIFFUSER
PULP SCREEN
PULP SILO
WET PULP
LIMING CARBONATION
CaO
CO_2
LIME KILN
SACCHARATE MILK
FILTERS
LIME MUD
EVAPORATORS
VACUUM PANS
CRYSTALLIZER
CENTIRIFUGE
MOLASSES
STEFFEN
GRANULATOR
STEFFEN FILTRATE
SUGAR
TO STREAMS

Figure 1. Type I Water Flow.

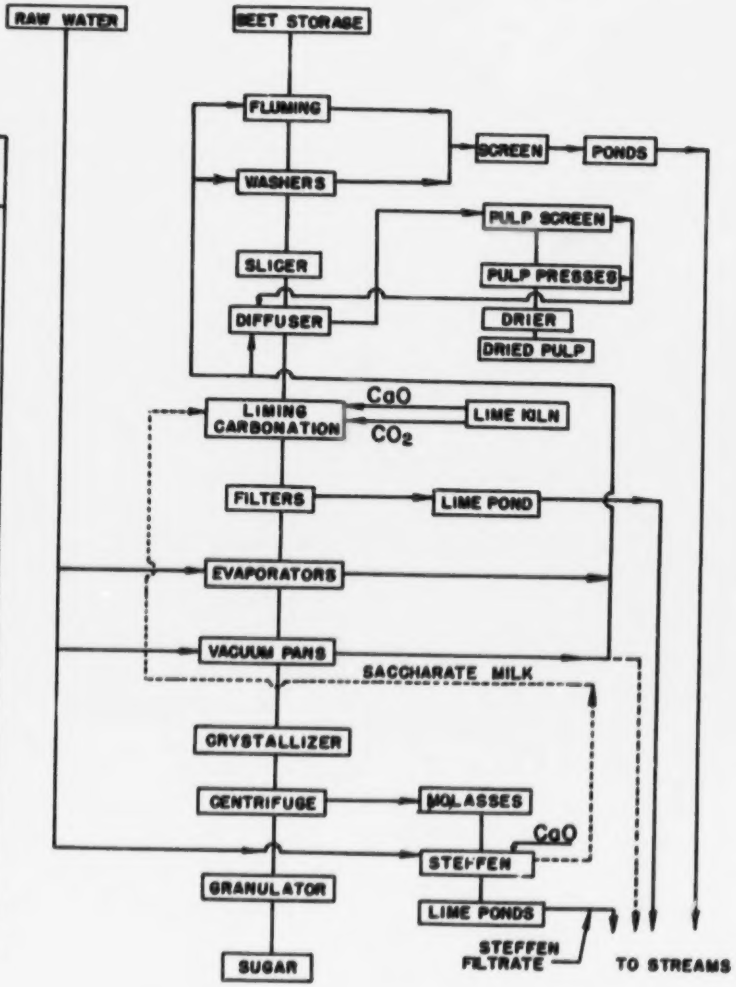
RAW WATER
BEET STORAGE
FLUMING
SCREEN
PONDS
WASHERS
PULP SCREEN
SLICER
PULP PRESSES
DIFFUSER
DRIER
DRIED PULP
LIMING CARBONATION
CaO
CO_2
LIME KILN
FILTERS
LIME POND
EVAPORATORS
VACUUM PANS
SACCHARATE MILK
CRYSTALLIZER
CENTRIFUGE
MOLASSES
CaO
STEFFEN
GRANULATOR
LIME PONDS
STEFFEN FILTRATE
SUGAR
TO STREAMS

Figure 2. Type II Water Flow.

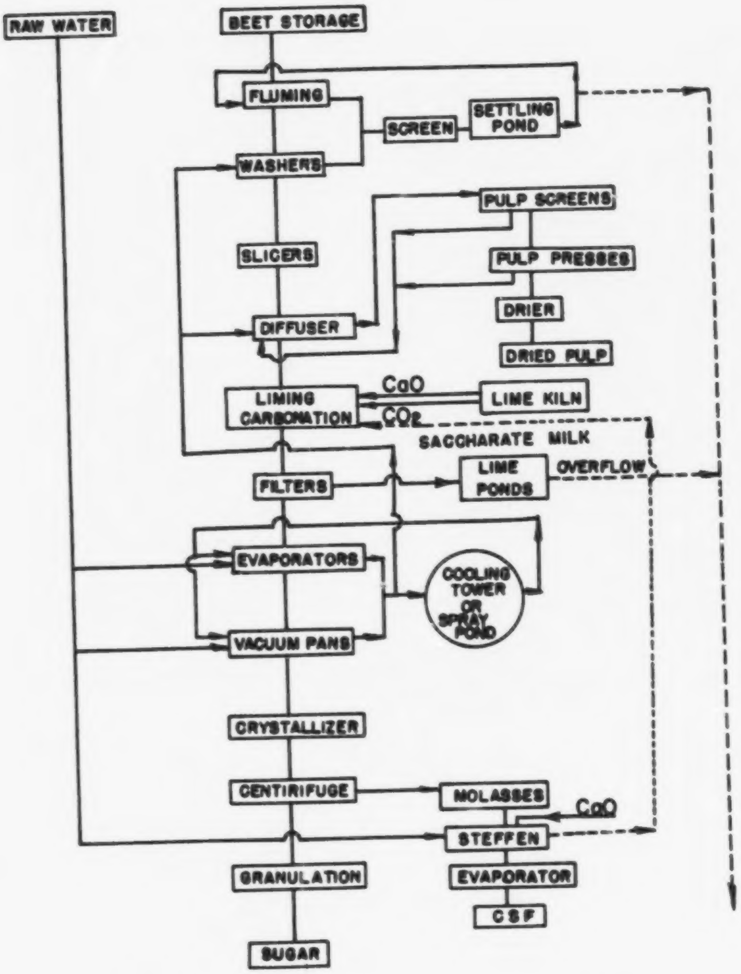
RAW WATER
BEET STORAGE
FLUMING
SCREEN
SETTLING POND
WASHERS
PULP SCREENS
SLICERS
PULP PRESSES
DRIER
DIFFUSER
DRIED PULP
LIMING CARBONATION
CaO
CO2
LIME KILN
SACCHARATE MILK
FILTERS
LIME PONDS
OVERFLOW
EVAPORATORS
COOLING TOWER OR SPRAY POND
VACUUM PANS
CRYSTALLIZER
CENTIRIFUGE
MOLASSES
CaO
STEFFEN
GRANULATION
EVAPORATOR
CSF
SUGAR

Figure 3. Type III Water Flow in Beet Sugar Factory.

The amount of water re-use varies greatly among the factories. At the Torrington factory, the total water usage, including re-use, exceeds the raw water intake by only 24 percent; at the Hereford, Texas factory the total usage exceeds intake water by 1,300 percent. Raw water is severely limited at the Hereford plant, hence great effort is made to conserve it. At most plants raw water intake constitutes one-third to one-half of the total usage. At six factories, however, fresh water constitutes less than 20 percent of the total use.

Type IV (Figure 4) represents a completely enclosed pattern of flow, except that at the end of the operating campaign, ponds are drained either to streams during spring floods or to municipal sewage treatment plants. Only three factories use this type of water flow.

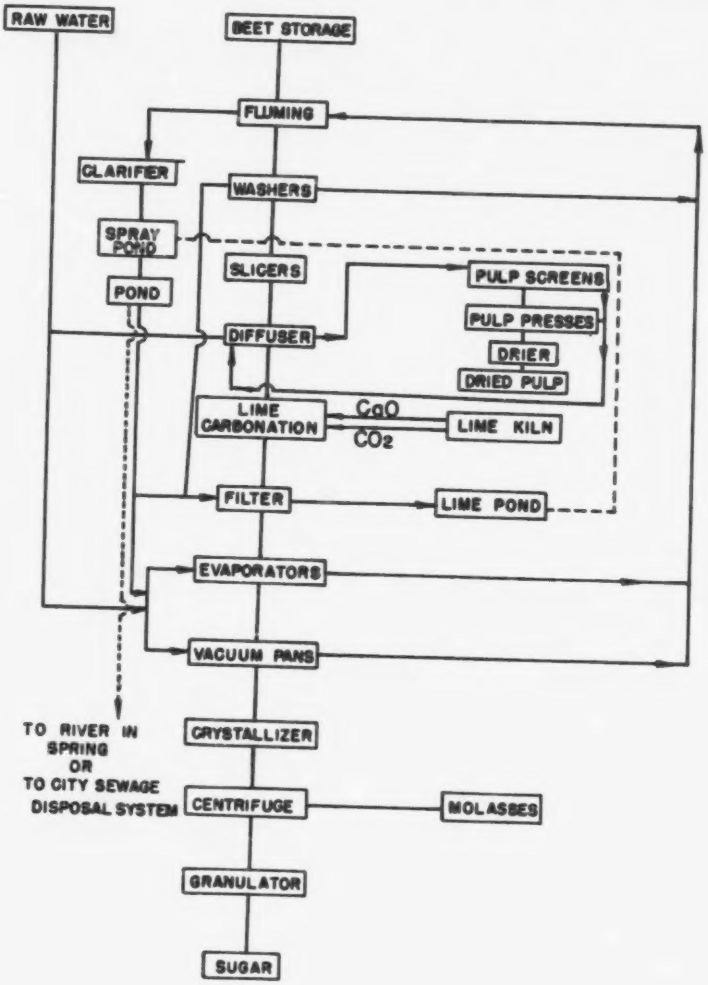
RAW WATER
BEET STORAGE
FLUMING
CLARIFIER
WASHERS
SPRAY POND
SLICERS
PULP SCREENS
POND
PULP PRESSES
DIFFUSER
DRIER
DRIED PULP
LIME CARBONATION
CaO
CO2
LIME KILN
FILTER
LIME POND
EVAPORATORS
VACUUM PANS
TO RIVER IN SPRING OR TO CITY SEWAGE DISPOSAL SYSTEM
CRYSTALLIZER
CENTRIFUGE
MOLASSES
GRANULATOR
SUGAR

Figure 4. Type IV Water Flow in Beet Sugar Factory.

SECTION VII

WASTE TREATMENT AND DISPOSAL

The five principal wastes from the sugar factory are: flume water, barometric condenser water, lime mud, general wastes (floor washes, equipment washes, etc.), and Steffen waste. To these might be added the sanitary sewer which, however, is usually discharged separately to municipal sewage plants.

Flume Water

The physical removal of suspended solids from flume water is the first treatment step. The amount of soil (dirt tare) varies greatly from one beet area to another and from season to season. In wet harvesting seasons the soil adhering to beets may exceed 10 percent of the weight of beets. In dry favorable harvesting seasons, particularly in areas of light sandy soil, the dirt tare may be only three or four percent. In any case suspended solids are removed in part from flume water in settling ponds or by clarifiers. J. Henry (32) in Belgium estimates dirt tare at about 14 percent on beets. This is much higher than is found in the United States, possibly because of greater rain fall and heavier soils in Europe. An important difference, however, is the much greater use of roller screens at beet receiving stations in America. Except in unusual seasons and under unusual conditions, dirt tare at factories in the United States amounts to five to six percent.

A factory slicing 400,000 tons of beets during a campaign will accumulate 20 to 24 thousand cubic yards of dirt in its settling ponds. At Nyssa, Oregon, 53,000 cubic yards of dirt were removed from lagoons in 1969 after processing 995,000 tons of sugarbeets.

Grit separators are employed by five factories to remove coarser material from recirculated flume water. Ten factories use conventional clarifiers to effect more complete separation of suspended solids before recirculation of flume water or discharge to ponds. The clarifier under-flow is pumped to mud ponds.

The flume water is screened to remove beet fragments, tails, etc., at all except 8 of the 58 factories. In most cases the flume water is ponded with the general wastes of the factory. At 12 factories, milk of lime is added to the flume water as it leaves the screens or enters ponds. This serves to keep the pH at a level which impedes bacterial action thus reducing odors. It also acts as a flocculating agent. Where flume water is recycled back to flumes the addition of lime allows the use of smaller settling lagoons in the system.

Barometric Condenser Water

Condenser and cooling water, in principle, is relatively unchanged by usage except for an increase in temperature to 50-55°C. Actually, condenser water always picks up some entrained solids. Pan condensers are prone to intermittent "shots" of liquor boiled over at some stage of the boiling cycle.

Data regarding the BOD content of condenser water are limited but tend to confirm previous findings, namely that sugar lost by entrainment amounts to about 1,800 lb. per day in a plant of 2,500 to 3,000 ton capacity. Suspended solids in the condenser water as it leaves the seal tank are low.

Re-use of condenser water is common practice thus reducing actual treatment. Thirty-eight factories use condenser water for fluming and other in-plant usages; twenty cool and recycle this water back to condensers. Many factories make some in-plant use of condenser water and discharge the remainder to streams.

Condenser water picks up ammonia from the evaporating juices, hence is always alkaline, ranging from 8 to 10 pH but usually less than 9. While undesirable, the discharge of this mildly alkaline condenser water into streams has rarely, thus far, met serious objection from pollution control authorities. A more serious objection to direct discharge of condenser water is its temperature which may be as high as 55°C. Where streams are small and sluggish, local temperature increases in the stream at the point of entry of the condenser water sometimes results in fish kill.

Lime Mud

The quantity of dry solids in the lime mud discharged by the factory ranges from about four to a little more than six percent of the weight of beets. The so-called lime cake discharged from the rotary filters contains about 50 percent solids but it is slurried with water to obtain a pumpable mixture of 20 to about 36 percent solids, usually about 25 percent. Treatment consists of shallow ponding.

Fifty-four factories discharge lime mud to separate lime ponds; five discharge it to the flume or general ponds. Twenty-seven factories report no overflow from these ponds. Mud transport water at these factories is lost by seepage or evaporation (in a few instances some overflow occurs). At five factories overflow from the lime ponds goes direct to streams; at twenty-two the overflow runs into the flume or general ponds. At the latter plants, the lime pond effluent is subjected to the same treatment as the flume and general wastes.

The quantity of lime cake retained in ponds is approximately the same as that of flume sediments--20 to 30 thousand tons a year. Only two factories now re-burn lime cake for the production of lime--Manteca and Mendota, California. The Alvarado factory of Holly Sugar Corporation has been shut down; the lime cake re-burning operation at Spreckels, California has been discontinued. Re-burning of lime cake was discontinued because of objections to the dust emitted by the rotary kiln. Lime cake from the Spreckels factory now is being shipped to the Mendota factory for re-burning.

Sale of lime cake for agricultural and other usages has not been notably successful. At only two factories--Tracy, California, and Toppenish, Washington, has any considerable outside use been made of it. The rather large store of lime cake at Tracy is being sold to farmers for use on peat soils at a somewhat faster rate than it is being produced. At Toppenish, a commercial distributor collects lime cake from the dry ponds for sale in areas with acid soils.

Cleaning of lime ponds is a continuing, expensive chore at all other factories. As a general practice, two or more lime ponds are available at a factory, enabling the operators to have one out of service each year so it can be dried and dug out.

Steffen Waste

The disposal of Steffen waste has been one of the most perplexing problems of the beet sugar industry. The solids in the waste consist principally of sodium and potassium salts and nitrogenous compounds--betaine and amino acids. The latter, though biodegradable, is not easily attacked in the usual biological treatment systems. The Steffen process has not been used in Europe, where it was developed, partly for this reason. In the United States a number of Steffen operations have been discontinued partly but not entirely because of the waste disposal problems.

At 14 of the operating Steffen factories the disposal of the waste has been satisfactorily accomplished by evaporation and subsequent use of the concentrated Steffen filtrate. Originally, impetus was given this procedure by the demand for CSF as a source of monosodium glutamate (MSG). Five factories of Great Western Sugar Company still ship CSF to the Johnstown, Colorado, MSG processing plant. The remaining nine Steffen factories dry the concentrate on beet pulp, directly. Other processes for the production of MSG have largely superseded recovery from Steffen waste.

To reduce the cost of evaporating Steffen filtrate considerable effort is made to keep the concentration of the thin waste as high as possible without adversely affecting the purity of the saccharate produced. One method used by The Great Western Sugar Company is the return of cold saccharate filtrate as part of the dilution water. The volume of thin Steffen waste is thus reduced from about ten tons per ton of molasses to about six.

Seven Steffen factories do not evaporate the waste. At some factories it is discharged to the lime ponds; at others to separate lagoons where it is allowed to evaporate or seep away.

General Wastes

General wastes include floor and equipment washes, filter cloth wash, and miscellaneous effluents. These wastes are usually discharged to the general ponds together with flume water and overflow, (if any), from the lime pond.

SECTION VIII

ASSOCIATED WASTE DISPOSAL PROBLEMS

The molasses desugarizing plant and the monosodium glutamate recovery plant at Johnstown, Colorado, while not beet processing plants, are an integral part of the industry in Colorado and Western Nebraska. These plants are necessarily included in this survey since their effluents constitute a part of the pollution of the South Platte River attributable to the beet sugar industry.

The two plants have a common water supply, a common stream and power plant, and a common waste disposal system.

The molasses desugarizing plant processed daily 230 tons of molasses received from Great Western Sugar Company beet sugar factories in Colorado and Nebraska. The MSG plant processes daily 115 tons (dry solids basis) of molasses residuals from the desugarizing plant and of concentrated Steffen filtrate from Great Western Sugar Company Steffen factories.

The gross water intake--both plants--is 4.2 million gallons a day, 3 million of which is pumped from the Little Thompson River, the remainder is obtained from wells and from the Johnstown city water system. Most of the raw water is used in barometric condensers in the two plants. There are two sets of evaporators and four sugar pans in the molasses plant and two evaporator stations in the MSG plant. The condenser water is returned to the river containing considerable BOD, presumably from entrainment.

Water is used extensively in both plants as miscellaneous washes for regenerating char columns, gas washing, etc. These, including floor drainage, go to the so-called "treated sewer" which is discharged into two one-acre ponds, 15 feet deep, operating in parallel. In each of these ponds a 60 HP aerator is mounted, each capable of delivering about 120 pounds oxygen per hour. The two ponds discharge into a 20-acre pond, 3 feet deep, partitioned to direct the flow in a tortuous path prior to discharge to the river. It was confidently predicted by the company engineers that this arrangement of ponds and aerators would reduce the BOD in the effluent from the plants to acceptable limits, i.e., to 800 pounds BOD per day. Present results show almost 2,800 pounds of BOD are being discharged to the Little Thompson River but the results are not conclusive. It is believed that the newly completed installation, when equilibrium conditions are reached, will reduce the discharge of BOD to the river to about 1,400 pounds per day.

SECTION IX

TREATMENT AND DISCHARGE OF EFFLUENTS

It is difficult to classify the waste treatment at the various factories since it ranges from little or no treatment to reasonably complete treatment. Procedures for reduction of BOD differ in principle; some companies rely chiefly on anaerobic fermentation in deep ponds, some on aerobic fermentation in shallow ponds with or without mechanical aeration.

In the following paragraphs these processes are discussed in some detail.

Preliminary to any treatment flume water or flume water plus general wastes are screened at all but eight of the 58 factories. By this means a large amount of solid organic material is eliminated which otherwise would settle in ponds to form a bed of slowly decaying material.

Three types of ponding are in use. The American Crystal Sugar Company at its four plants in the Red River Valley in Minnesota employs large ponds capable of holding nearly all the wastes produced during the campaign. Usually some waste discharge is permitted during the early part of the campaign, so regulated as to avoid raising the BOD level of the river above permissible limits and reducing dissolved oxygen below acceptable limits. After the river freezes over all discharge of waste to the stream is stopped. All factory effluent is held until the spring thaw at which time the ponds are emptied at a carefully regulated rate based on BOD content of the effluent and the flow of the river.

Discharge of waste at Moorhead, may be at a rate of one million gallons per day, or at one-half million or less when the river is low. The dissolved oxygen, normally about 8 ppm above the point of discharge diminishes to about 7 ppm below the plant. BOD content of river water above discharge from ponds is about 3.6 ppm; below as much as 5.6 ppm. Some reduction in BOD content of the ponded waste takes place during the long storage period and prior to regulated discharge to the river, but the reduction in storage is usually not significant.

The Crookston, Minnesota factory discharges its ponded wastes into the Red Lake River which, in turn, empties into the Red River of the North near Grand Forks. Discharge is regulated, as at Moorhead, to maintain favorable conditions in the river at all points downstream, i.e., a minimum of 5.0 ppm of dissolved oxygen. Records on discharge of wastes from the Crookston factory between October 3, 1968 and December 7, 1968 show a total discharge of 362 million gallons of pond water with an average BOD of 500 ppm plus one million gallons of

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lime pond overflow with a BOD of 4,500 ppm. This is an average of 24,000 lbs/day. From December 8 no further discharge was permitted until the "spring thaw" starting on April 18, 1969. Between this date and June 6, 1969 about 408 million gallons of pond water and 17 million gallons of lime pond water were discharged. The BOD of the discharge from the ponds was an average of about 1,050 ppm and 4,400, respectively for an average daily release of approximately 84,000 lbs of BOD to the river. The rate of discharge of each of these effluents was controlled to prevent unfavorable stream conditions at any time.

Similar control of waste discharges to the river is maintained at the East Grand Forks, Minnesota and the Drayton, North Dakota factories. The BOD discharged per ton of beets at these Red River factories of American Crystal ranges from 3.5 to 14 lbs but its entry into the river is spread over a period of six to nine months.

Another type of long-term retention in ponds is exemplified by factories of the Spreckels Sugar Company. In this type no discharge of effluents to streams is permitted at any time. The waste is eventually dissipated by evaporation and seepage, or in some cases, by use of the pond water for irrigation. At the Woodland, California factory the ponds are shallow and cover large areas. Reduction in BOD content is due to aerobic action primarily. At the other Spreckels factories, reliance is placed principally on anaerobic action in relatively deep initial ponds followed by shallow ponds. These practices appear to be successful. Some odor problem was reported at the Spreckels (Salinas) plant. Several aerators are in use and more planned to alleviate this nuisance. There is no detectable pollution of streams by any of the Spreckels factories.

The Moses Lake factory of the Utah-Idaho Sugar Company also uses a long-term retention ponding system although the pond area in use is not large--45 acres. Extensive recirculation of flume and condenser water permits a very low intake of fresh water--only 580 gallons per ton of beets, hence a small discharge to ponds. The waste is completely dissipated by evaporation and seepage.

The Hereford, Texas plant of Holly Sugar Corporation also practices remarkably complete recirculation of waters with very low intake of fresh water--215 gallons per ton of beets. Although large areas are available for ponding of wastes, actually little is used. Ponds for collection of flume wastes are intermediate in depth--8 feet. There is no discharge to streams.

The Goodland, Kansas factory of The Great Western Sugar Company, like the Hereford plant, depends on extensive recirculation and low intake of fresh water--only 328 gallons per ton of beets--to reduce wastes to a volume that can be totally contained without discharge to streams.

Seventeen factories report either no discharge of BOD to streams or the discharge of quantities less than one pound per ton of beets sliced.

In general, factories in Montana, Wyoming, Nebraska, and Colorado report relatively large amounts of BOD per ton of beets discharged to streams. Notable exceptions are the factories at Longmont, Eaton and Brighton, Colorado, where remodeling of waste disposal facilities has been completed. Similar changes at other factories in the South Platte river valley are planned for the near future.

A calculation based on these figures and on the annual slice rate of each factory shows that in 1968 all beet sugar factories discharged to streams 82,016,000 pounds BOD. The total tonnage of beets sliced was 26,071,000. The average pounds BOD per ton of Beets sliced was, therefore, 3.15. However, 17 factories showed no discharge of BOD to streams. The remaining 41 factories therefore discharged an average of 4.8 pounds BOD per ton of beets sliced.

SECTION X

COST OF WASTE DISPOSAL FACILITIES

The annual operating cost includes intercampaign costs of cleaning ponds and maintenance. The costs reported may not be quite accurate in some cases due, in part, to the difficulty of separating cleaning and maintenance costs from the cost of improvements of existing facilities. The cost of land should not have been included in these estimates but in a few cases land cost, or some of it, is probably included. For the most part, these estimates include only the cost of forming dikes, leveling pond basins, construction of pump houses and concrete structures, cost of pumps, piping, mechanical separators, screens, motors, control devices, etc.

Löf and Kneese in "The Economics of Water Utilization in the Beet Sugar Industry" prepared for Resources for the Future, Inc. in 1967, review waste treatment costs for the beet sugar industry. Their figures show the same wide range of capital expenditures at various plants that the present survey shows, namely, from a few thousand dollars to more than half a million (one reports five million). Also, annual operating costs vary widely. Some factories report as little as one thousand dollars--some 30 to 40 thousand.

A figure by Lloyd Jensen which has been widely quoted and which Löf and Kneese mention in their report is 30 million dollars in capital expenditures for the entire beet sugar industry as the amount necessary to completely eliminate pollution of streams. This means about one-half million for each factory. Table 11 in the appendix indicates some plants have accomplished a great deal with much less; some have accomplished much less with larger amounts.

The ultimate solution of the problem of stream pollution by the beet sugar industry will probably require the following at each plant:

1. Equipment for screening of wastes to remove beet fragments, leaves and other organic solid material.

2. Equipment for complete separation of the soil and other matter suspended in the flumes and general wastes. This may mean mechanical equipment or ponds.

3. Areas for the permanent disposal of dirt. About 100 pounds of dirt per ton of beets sliced must be allowed for. A factory slicing 300,000 tons a year will, in 20 years, require storage space for about 200,000 cubic yards of soil.

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SECTION XI

LABORATORY AND PILOT PLANT WORK ON WASTE TREATMENT

A project sponsored by the Beet Sugar Development Foundation, the "Treatment of Beet Sugar Plant Flume Water" was conducted by the British Columbia Research Council, University of British Columbia, Vancouver, B. C. in 1964. A complete report by T. E. Howard and C. C. Walden is available. A summary of their conclusions follows:

1. The report is limited to studies on BOD reduction at four factories: Billings, Montana; Tracy, California; Moses Lake, Washington; and Winnipeg, Manitoba.

2. Any build-up in BOD loading, at a mill recycling a constant percentage of flume water, occurs in less than one week from the start of campaign.

3. Beet flume wastes are susceptible to biological oxidation.

4. Using beet muds as a source of inoculum, start-up rates are slower than desirable, evaluated on a weekly batch-type fermentation. Subsequently, with an established floc, the rates of BOD removal are entirely adequate to handle high BOD loadings.

In a subsequent report it was found:

1. Biological oxidation was an effective procedure for the reduction of BOD: 93.1 to 96.8 percent of BOD load was removed by an active floc.

2. Maximum BOD removal rates were obtained within 96 hours.

In a later report of experiments in which flume wastes from 48 beet sugar factories were subjected to bio-oxidative treatment, it was shown that significant BOD reduction was obtained in 72 hours of aerobic treatment.

The Beet Sugar Development Foundation with support funds from EPA, (formerly Federal Water Quality Administration) sponsored pilot plant work on treatment of beet sugar factory wastes at the Tracy plant of the Holly Sugar Corporation. The essential features of the procedure followed in these experiments are as follows:

Factory wastes, principally flume water, after screening and removal of settleable solids by mechanical means, are run into three ponds in succession; the first pond, about 20 feet deep, operates as an

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anaerobic fermenter, the second shallower pond acts as a facultative pond, and the third, still shallower and much larger as an aerobic pond in which algae grow.

Flows in the ponds were carefully controlled, changes in pH and in BOD content were determined and the numbers and kinds of organisms present were investigated. Results which in general were satisfactory, have been reported elsewhere. (86)

Substantially this procedure is currently being used for the treatment of wastes at the Manteca, California, plant of the Spreckels Sugar Company. Some modifications have been made. The results are apparently satisfactory.

Wider use in the industry has not been made, partly because temperatures during the operating season in many areas are often below freezing, hence the biological action would not be as satisfactory as in California—or so it is believed.

A full-scale plant experiment has been conducted in 1967-69 by the Beet Sugar Development Foundation and the Environmental Protection Agency at Longmont, Colorado. Reports of these tests are in progress so only the general plan and results will be discussed here.

Flume water after screening to remove organic debris is run into channels about 40 feet wide at the top, 12 feet deep and about 600 feet long in which suspended solids are deposited. Milk of lime is added after the screening operation to improve the settling rate. The liquid flows from the channel into a secondary pond from which it is recirculated to the flumes. Make-up water is added by the spray over the roller conveyor which carries the beets from the beet washer to the elevator. Any excess water that may build up is drawn off the secondary pond to a larger and deeper (about 15 feet deep) storage pond where anaerobic micro-biological action takes place.

The channels where primary settling of muds takes place are arranged in duplicate so that flow may be directed from one while the other is being cleaned. The removal of wet mud from these channels during the operation period proved troublesome.

The installation at Longmont has been closely studied by the Foundation to determine the relation of pH, alkalinity and other factors on settling rates. The number and kinds of microorganisms have been investigated as part of the overall study.

Some odor problems have arisen from the storage pond. Aerators have been installed in the system to reduce odors.

The Amalgamated Sugar Company uses a system similar to this at Nyssa, Oregon. The channels are arranged in a horseshoe shape around a central secondary pond.

Some studies are being made by individual companies, directed toward reducing pollution by improved "housekeeping." Also, efforts are being made to transport lime mud by the use of minimum amounts of water.

SECTION XII

PROBLEMS REQUIRING ADDITIONAL RESEARCH AND DEVELOPMENT

Two of the major problems confronting the industry in connection with waste disposal are the disposal of muds and the lessening of odors from ponds and muds. Both of these previously have been referred to.

The use of mechanical separators (hydroseparators, thickeners) allow the concentration of facilities for separation of soil in a small area. Cost and maintenance of the equipment represents a considerable outlay. Ultimately the muds so separated must be transported to permanent storage areas at additional cost.

J. Henry (32) in his survey of the beet factory waste problem in Europe with particular emphasis on Belgium apparently views the mud disposal aspect with some pessimism. Mud disposal at a factory necessarily becomes increasingly burdensome with time as the volume builds up and disposal areas shrink.

The use of large settling ponds permits disposal of muds in their final storage place with only the requirement that the deposited soil be lifted to the remaining dikes, thus raising the level of the ponds higher and higher as time goes on. Veterans in the industry are often shocked to see, after the passage of several years, the increased height of pond walls at some factories (Moorhead, for example). Yet this may be one of the more economical solutions of the problem.

The second exasperating problem of waste disposal at sugar factories is the matter of odor. When most of the factories were built, i.e., prior to 1930, they were located downstream from small towns. Inevitably, the towns have grown often pressing close to the plant so that smoke and fly ash from the boiler house and odors from the ponds become very objectionable. Better combustion in boiler houses and the conversion from coal to gas fired boilers have lessened the fly ash problem. The odor nuisance possibly has been made acute by required efforts to avoid pollution of streams. At factories that discharge all wastes--mud, lime cake, pulp water, condenser water--direct to streams diluted with as much water as they could pump, there was less time for the development of hydrogen sulfide and putrefactive odors.

Ponding, particularly in deep anaerobic ponds, frequently promotes the growth of sulfur reducing organisms. It has been observed that careful screening of wastes to remove organic matter which settles out forming a septic bed on the floor of the pond, lessens the quantity of noxious gases discharged. However, the floc formed during biological treatment of wastes becomes an unsavory component of the treatment ponds promoting the formation of unpleasant odors.

SECTION XIII

DISCUSSION

The magnitude of the pollution of streams by beet sugar wastes is still very great, approximately 2,200 gallons containing an average of 3.15 pounds BOD per ton of beets sliced (4.8 pounds if only discharging factories are used for computation). The total discharge to streams from the entire beet sugar industry in the United States in 1968 was about 57 x 10^9 gallons containing about 82 x 10^6 pounds BOD. The beet crop in 1968 was unusually large; possibly a more normal crop to be expected is 22 million tons instead of 26 million tons.

It should be pointed out that the pollution by beet sugar factories has been greatly reduced in recent years. Before the advent of continuous diffusers and of pulp driers, the amount of BOD discharged to streams was about 30 pounds per ton of beets. At Steffen factories before evaporation of Steffen waste was generally practiced, the BOD discharge from these factories was 40 pounds per ton of beets. Improved ponding of general wastes has also contributed to the reduction of pollution of streams by beet factories.

Much of the beet sugar industry is located in lightly populated areas of the western part of the United States. Most of this area is semiarid. Streams are relatively small, hence, the influx of even relatively small amounts of organic wastes becomes objectionable. The beet sugar industry is often the only industry of importance in its area, hence, produces most of the pollution of the area streams.

Under the present Sugar Act, the beet sugar industry is permitted to increase at a rate of 3 percent a year. Such growth and development of beet areas and manufacturing facilities will be in new areas as well as in present beet-growing areas. Some companies anticipate very large increases at certain factories--some little or no growth. Increases in slicing rates (and total annual slice) will result in increased waste disposal problems at some factories--at others, very little. The pollution problem is recognized by all processors, now, and is apparently carefully considered when expansions are planned. The marked tendency toward reduced usage of new (fresh) water by the re-use of water permits considerable expansion without added waste disposal facilities.

The present processes available to treat beet sugar factory wastes have been described in previous sections of this report. Common to all processes is the requirement for adequate screening of wastes to remove fragments of beets and other organic matter and facilities, either mechanical or other, for separation of muds. The method of handling the clarified or partly clarified liquid wastes may be one of the following: (a) direct discharge to streams during periods of floods (where this is permitted), (b) anaerobic biological treatment in deep ponds, followed usually by aerobic action in shallow ponds or ponds equipped with mechanical aerators, or (c) aerobic fermentation only. To these should be added biological (trickling) filters; also the use of waste disposal facilities, jointly with neighboring municipalities.

The pollution load produced by a factory before any corrective action is taken is, approximately:

	BOD lb/ton beets	Suspended Solids - lb/ton beets	
		Soil	Lime Cake
Straight houses	30-35	80-250	60-100
Steffen houses	40-45	80-250	100-140

With the use of continuous diffusers, pulp presses, pulp driers and the complete recirculation of pulp press water, the BOD discharged in the waste may be reduced by about 17 pounds per ton of beets sliced. By retaining lime muds in ponds with no overflow, a further reduction of about six pounds BOD per ton of beets sliced is affected. The elimination of Steffen waste from the factory effluent by concentration and disposal as cattle feed reduces the pollution load by about 230 pounds of BOD per ton of molasses worked. The amount of molasses worked varies considerably but ranges usually between four and six percent of the weight of beets sliced. The BOD in the Steffen waste is therefore, ten to eleven pounds per ton of beets.

It is apparent that the BOD in wastes that must be subjected to biological treatment can be, and is in most U. S. factories, reduced to that contained in flume water, condenser water and floor washings, i.e., five to ten pounds per ton of beets. Unfortunately, these quantities are frequently exceeded due to accidental spills in the house or to the introduction of deteriorated beets into the flumes.

The removal efficiencies of present waste treatment processes are difficult to assess. Adequate BOD determinations are infrequently available in statistically significant numbers. Exceptions to this are, of course, the intensive studies (88) made by the EPA (formerly Federal Water Quality Administration) on pollution in the South Platte River (June 1967) where the systems of treatment investigated were found completely inadequate, and the various studies of experimental units conducted by the companies or by the Beet Sugar Development Foundation. It is reasonably certain, however, that the facilities outlined on pages 33-34 of this report can be made adequate to reduce stream pollution to presently acceptable levels. Obviously, those few factories that contain all their wastes, with no discharges to streams, cause no direct stream pollution. Contamination of ground waters or even of streams by seepage is perhaps possible.

The cost of construction of adequate waste treatment facilities for beet sugar factory wastes will vary greatly among factories. An engineering estimate for each individual factory is beyond the scope of this report.

Such an estimate must include several items not usually thought of as waste disposal facilities. Among these are changes in water supply to re-use water in the plant; changes in means of removal of lime cake from the factory without dilution, and others. Additional land may be required at several factories, primarily for disposal of mud and lime cake. The writer(s) of this report held the opinion that Mr. Lloyd Jensen's generalization that the cost would be about $500,000 per average factory was possibly high; after this survey we take a much more pessimistic view, namely, the cost may be considerably higher--possibly $750,000 at many plants. The annual operating cost of waste disposal is estimated by us to approach $0.25 per ton of beets sliced, however, newer installations operate at half or less that amount. These figures will include power, maintenance and pond cleaning costs.

Gaps in the technology of beet factory waste disposal, at first glance, appear to be trivial; it has been demonstrated that beet wastes are amenable to treatment. As indicated previously, two approaches are currently being used: anaerobic biological action and aerobic fermentation. The former, according to Tsugita, et al. (86) is probably the most efficient and leads to the most nearly complete stabilization of BOD. It, however, gives rise to objectionable odors including particularly, the odor of hydrogen sulfide. At many factories, neighboring residents have protested this annual nuisance.

Besides the continued study of factory scale bio-treatment of wastes, an economic and engineering study is required to determine the most practical and economic means of solid waste disposal.

SECTION XIV
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SECTION XV

GLOSSARY

campaign - (French) the period of the year during which the beet factory makes sugar.

cossettes - thin strips of sugarbeet root tissue produced from the knives of the slicer.

diffuser - an apparatus into which water and cossettes are fed, the water "dissolving" sugar from the sugarbeet cells.

filtrate - liquid after passing through a filter.

granulator - a rotary drier used to remove free moisture from sugar crystals prior to packaging or storing.

lime mud - the washed calcium carbonate filter cakes, including sludges from first and second carbonation.

nonsugar - any material present, aside from water, which is not a sugar.

pan - a single-effect evaporator used to crystallize sugar.

process water - water which is used in the internal juice streams from which sugar is ultimately crystallized.

pulp press - a mechanical pressure device which squeezes the exhausted cossettes (pulp) removing some of the water.

saccharate milk - a slurry of (calcium saccharate) cakes from the Steffen process.

seal tank - the seal on the bottom of a barometric leg pipe.

slicer - usually a drum on which V-shaped corrugated knives are mounted. This machine produces the cossettes.

slicing capacity - processing capacity, the number of tons of sugarbeets a factory is capable of processing in a 24-hour period of time.

Steffen process - a process of treating molasses to produce a precipitate containing sucrose which can then be treated to release free sucrose in solution.

% on beet - ratio of a quantity to clean beet weight.

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APPENDICES

SELECTED WASTE WATER SCHEMES
IN OPERATION AT SUGARBEET FACTORIES
IN EUROPEAN COUNTRIES AND GREAT BRITAIN[1]

INTRODUCTION

This section contains information on water schemes and methods of treatment of waste waters in operation at: (1) German factories--Ameln, Schladen, Wabern; (2) British factories--Ely, Newark, Wissington; (3) a Swedish factory--Örtofta; and (4) a Swiss factory--Aarberg.

Costs of installing and operating each plant are reported. Estimates from Belgium have been included and information of a more general nature relating to developments in France and the Netherlands also has been included.

GERMANY

Nowhere on the Continent have the various problems associated with waste waters apparently received more attention than at the Ameln factory of Pfeiffer and Langen. The developments which have taken place there are fully described and discussed in the papers authored by Langen and Hoeppner (4) and F. W. Meyer (5).

The first of these papers gives details of the various water cycles which have been set up and of the storage basins for receiving mud and water (Figure 5). Settled water from the mud ponds is eventually stored in a rectangular shaped lagoon, covering 6 acres and holding at the end of the campaign about 31 million U. S. gallons, before being fed to an activated sludge plant. The first paper gives details of the costs of installing and operating the activated sludge plant supplied by the Lurgi Company, and the second paper amplifies on the improved performance of the plant.

The quantity of water to be purified corresponds to about 57 percent of the weight of beets to be processed but it is pointed out that this amount could be reduced by about 17 percent on beet weight if the water from the gas washer was not used as a spray to clean the beets after they emerge from the beet washer. Furthermore, an additional saving of 4 percent on beet weight could be achieved if the

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[1] By A. Carruthers, Director of Research (Retired), British Sugar Corporation Ltd.

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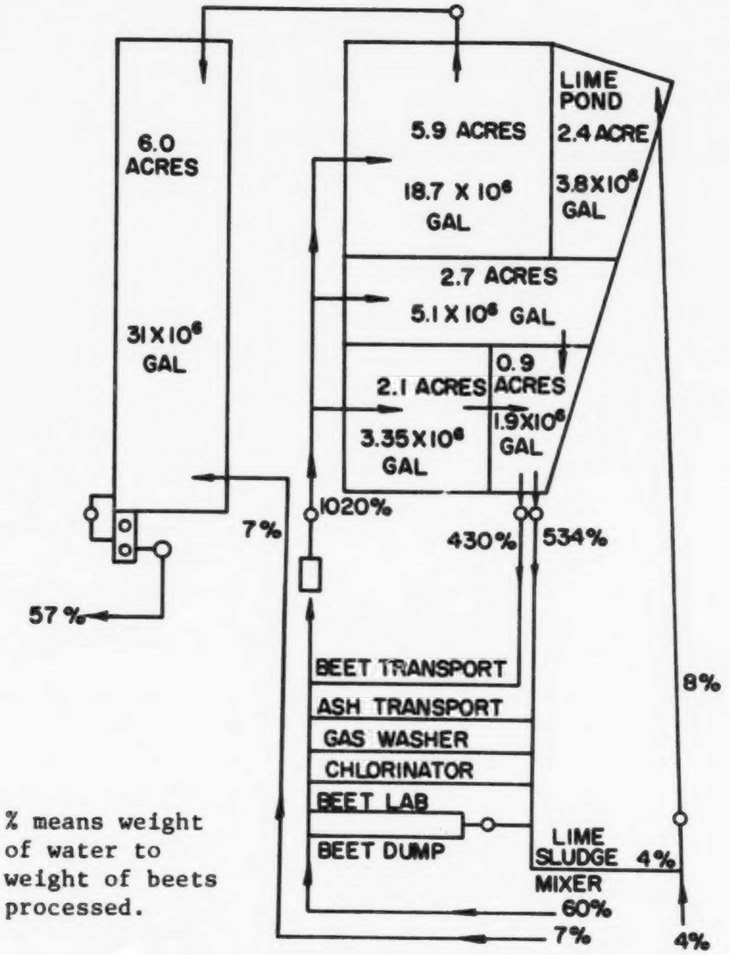
6.0 ACRES
31 X 10⁶ GAL
5.9 ACRES
18.7 X 10⁶ GAL
LIME POND
2.4 ACRE
3.8 X 10⁶ GAL
2.7 ACRES
5.1 X 10⁶ GAL
2.1 ACRES
3.35 X 10⁶ GAL
0.9 ACRES
1.9 X 10⁶ GAL
1020%
7%
430%
534%
57%
8%
BEET TRANSPORT
ASH TRANSPORT
GAS WASHER
CHLORINATOR
BEET LAB
BEET DUMP
LIME SLUDGE MIXER
4%
60%
7%
4%

% means weight of water to weight of beets processed.

Figure 5. Waste water scheme - Ameln factory (Pfeiffer and Langen).

capacity of the cooling tower, operating on the condenser water, were increased by installing forced draft. The latter proposition is not considered to be economical, and presumably the need for the spray application on the beets is a reflection of the quantity of soil being delivered to the factory. The yearly rise in level of soil in the two basins of 2.7 acres and 2.1 acres is said to be 0.5 meter.

At the Ameln factory, unlike the practice adopted at many other factories on the Continent, lime sludge is not combined with thickened mud for discharge to ponds. The sludge, mixed with a very small quantity of water, is conveyed by a Moyno pump to a basin of 2.4 acres where it readily dries out in the summer.

To the water being returned from the final settling pond (area 0.9 acre) chlorine is added at a dose rate of $15 g/m^3$ which is equivalent to 15 ppm. It is interesting to note that some factories operating with closed systems add chlorine to the return water mainly to avoid an unpleasant sulphide odor at the beet end.

Schneider and Hoffman-Walbeck (8) recommend addition of lime to recycled transport water sufficient to maintain the pH at or above 11.0 since under these conditions bacterial action is greatly inhibited. It is noteworthy that at Ameln, because the capacity of the lime kiln is limited, lime is not added to the return transport water although it is recognized that by raising the pH the settling rate of the mud could be increased. To meet the lime requirement of 0.3 percent CaO on beet would cost $8,000.

The Ameln factory is situated in an area of very productive agricultural land, and since an area of some 30 acres would be required to permit natural purification (the depth of water not exceeding 1.2 meters), it became economically attractive to examine other alternatives critically. The factory particularly had in mind that if the polluted waste water could be suitably treated it could then be discharged into a river. In the light of the inevitable tightening of the regulations in Germany governing the discharge of polluted waters, Ameln may claim "to have done the necessary homework."

The activated sludge plant consists of an aeration tank, a Bruckner clarifier and two Vortair aerators each fitted with 15 kw motors and capable of supplying 3,000 lbs O_2/kw hr. The annual operating cost is about $60,000. The aeration tank is designed for a throughput of 4,700 gallons/hour at a BOD level of 2,500 ppm and allows a residence time of 24 hours. The clarifier, made of concrete, is 18 feet in diameter and has a capacity of about 12,000 gallons.

Running costs of the sludge plant are estimated to be approximately 19¢ per m^3 of waste water discharged or 7¢ per kg BOD. The distribution of the costs is as follows:

	Percent
Electricity	20
Chemicals	17
Labor	6
Maintenance	12
Operating Costs	55
Depreciation (10%)	28
Interest (6%)	17
	100

Over the past 15 years the following measures were achieved at Ameln:

1. The amount of water used was drastically reduced by establishing closed cycles.
2. Larger storage ponds and lagoons were provided.
3. An activated sludge plant was installed.

Even when these developments were spread out over 15 years the financial burden on the sugar company was severe. The costs of operating the activated sludge plant are only a fraction of the total costs resulting from the over-all waste water problem. It is estimated that the total costs (including amortization) are equivalent to a charge of 24¢ per 100 kg of sugar produced, or put in another way, they represent a charge of 55¢ per m^3 of waste water treated or 22¢ per kg of BOD removed.

Figure 6 is a diagram of water flow at the Schladen factory; only weakly polluted water is discharged to the channels leading to the river. Water characteristics are summarized in Table 3. Condenser water is cooled in a spray pond and recycled. Surplus water together with gas washer water and blowdown is discharged into Channel II leading to the river.

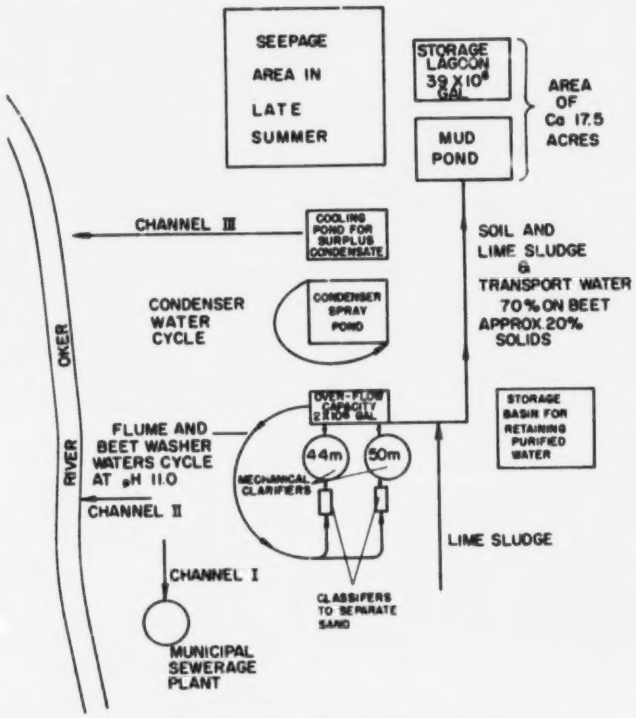
SEEPAGE AREA IN LATE SUMMER
STORAGE LAGOON 39 X 10⁶ GAL
MUD POND
AREA OF Ca 17.5 ACRES
CHANNEL III
COOLING POND FOR SURPLUS CONDENSATE
SOIL AND LIME SLUDGE & TRANSPORT WATER 70% ON BEET APPROX 20% SOLIDS
CONDENSER WATER CYCLE
CONDENSER SPRAY POND
OKER
RIVER
OVER-FLOW CAPACITY 2 X 10⁶ GAL
STORAGE BASIN FOR RETAINING PURIFIED WATER
FLUME AND BEET WASHER WATERS CYCLE AT pH 11.0
44m
50m
MECHANICAL CLARIFIERS
CHANNEL II
LIME SLUDGE
CHANNEL I
CLASSIFERS TO SEPARATE SAND
MUNICIPAL SEWERAGE PLANT

Figure 6. Schladen factory waste water scheme.

Table 3. Water Characteristics of the Schladen factory (Germany).

Name of Company	Nordharzer Sucker A. G.
Annual beet tonnage processed	330,000
Average 24-hour tonnage processed	3,200
Gross fresh water intake gallons/day	1.6×10^6 or 200% on beet
Source of fresh water	River Oker
Treatment of fresh water	Gravel filtered
Type of diffuser	Tower, with return of pulp press water
Quantity of water discharged to river	
1. Surplus condenser water as well as gas wash water and blowdown	154% on beet BOD = 22 ppm
2. Cooled excess condensate	16% on beet BOD = 48 ppm
Quantity of stored water - gallons	39×10^6 = 46% on beet
Period of storage - days	200
BOD discharged - lbs/ton beet	0.05

Flume and beet washer waters are de-sanded in two classifiers and then mud is allowed to settle in two thickeners, one of 50 and the other of 44 meters diameter and having a depth of 1.5 meters. The overflowing water passes to a further settling basin having a capacity of almost 2 million gallons.

The thickeners have mechanical scrapers and the mud from them is combined with lime sludge and pumped to the settling area. From the first basin, water flows to a storage lagoon and there undergoes natural purification. In August the partially purified water having a BOD of 300 ppm is used to irrigate an adjoining area of land.

The construction costs of waste water facilities at Schladen are given as $250,000 and annual operating costs at $7,500 including labor.

The water sheme adopted at the Wabern factory is shown in Figure 7. Condenser water is cooled in a spray pond and 590 percent on beet out of 600 percent on beet is recycled.

Surplus condenser water and condensate are stored in a basin of 7.8 x 10.6 gallons capacity, and by the early part of the year following the campaign the combined water has undergone self-purification and is discharged. See Table 4 for details.

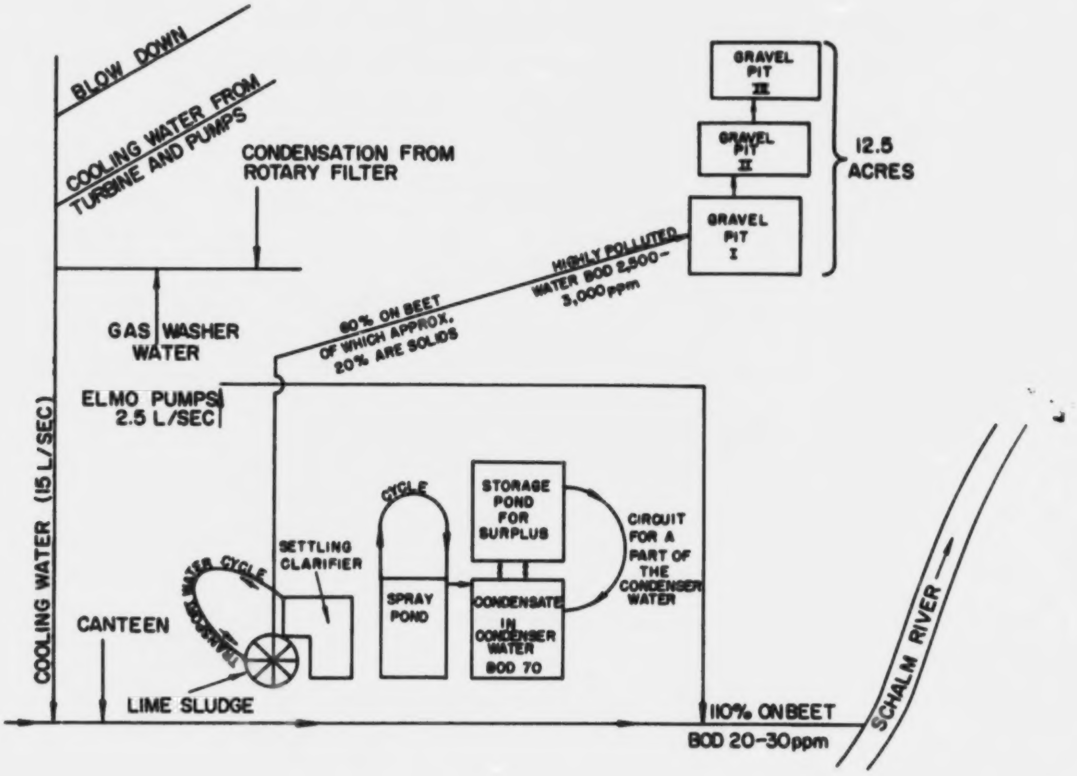
BLOW DOWN
COOLING WATER FROM TURBINE AND PUMPS
CONDENSATION FROM ROTARY FILTER
GAS WASHER WATER
ELMO PUMPS 2.5 L/SEC
COOLING WATER (15 L/SEC)
CANTEEN
LIME SLUDGE
WATER CYCLE
SETTLING CLARIFIER
CYCLE
SPRAY POND
STORAGE POND FOR SURPLUS
CONDENSATE IN CONDENSER WATER BOD 70
CIRCUIT FOR A PART OF THE CONDENSER WATER
60% ON BEET OF WHICH APPROX. 20% ARE SOLIDS
HIGHLY POLLUTED WATER BOD 2,500-3,000 ppm
GRAVEL PIT I
GRAVEL PIT II
GRAVEL PIT III
12.5 ACRES
110% ON BEET
BOD 20-30ppm
SCHALM RIVER

Figure 7. Wabern Factory Water Scheme.

Transport and beet washer waters are first led to a small thickener which is fitted with a mechanical scraper (this equipment was made in the factory). Mud from the thickener is pumped together with lime sludge to an unused gravel pit.

The water from the thickener flows to a settling basin and is recycled. The settling basin has to be cleaned out every campaign at a cost of $10,000. The muddy transport water also carries the regenerant liquors derived from the Quentin process and has a BOD content of 3,000 ppm. From the gravel pit the water flows into two ponds where natural purification occurs and the water gradually evaporates and percolates away. The three ponds cover an area of about 12.5 acres.

The waste water treatment facilities at Wabern are estimated to have cost $75,000 and the annual operating costs are $17,500 including labor.

Table 4. Water Characteristics of the Wabern Factory (Germany).

Name of Company	Actien-Zuckerfabrik Wabern
Annual beet tonnage processed	162,000
Average 24-hour tonnage processed	1,800
Gross fresh water intake gallons/day	0.7×10^6 or 150% on beet
Treatment of fresh water	Gravel filtered
Source of fresh water	River Schwalm
Type of diffuser	Tower, with return of pulp press water
Quantity of water discharged to river - gallons	0.54×10^6 or 116% on beet
BOD discharged - lbs/ton beet	0.05
Quantity of stored water - gallons	16.9×10^6
Period of storage - days	300 to 400

GREAT BRITAIN

At all factories transport and beet washer waters are re-circulated, and the amount of water which accumulates varies from as little as 30 percent up to 45 percent on beet. Several methods have been adopted for the disposal of the heavily polluted water remaining after soil has settled out. Direct discharge to estuaries or to tidal rivers occurs at five factories.

The privilege of being able to discharge heavily polluted water, even under these circumstances, is always subject to review, and it is in fact highly probable that in a few years the practice may be changed at two factories. Anything, therefore, which a factory can do to reduce the BOD load to the river is worthy of attention.

At one of these factories the water from the main settling basin (locally known as the "pulp lake" which term savors of the bad old days) flows through two rather small ponds, each about 150 yards square, before going to the river. In the first of these ponds four 25 hp surface aerators were recently installed, and after a lag period during which a sludge developed, the BOD of the water leaving the pond was reduced from 1,200 ppm to 350 ppm. Sludge which overflowed from the aeration pond was trapped in the next pond. This study is continuing.

Discharge to rivers (non-tidal) of water purified by trickling filters occurs at five factories. Provided that they receive a measure of attention the trickling filters perform satisfactorily and readily produce an effluent suitable for discharge to rivers, even where one of the requirements is that the BOD shall not exceed 20 ppm. Care has to be taken, however, to prevent the concentration of suspended solids in the effluent exceeding the usual limit of 30 ppm, and settling tanks of improved design, which will help in this respect are being studied.

Discharge to rivers (non-tidal) of water purified by an activated sludge system occurs at two factories.

The system adopted is that known as the Passveer Ditch and a description of the plant and its performance at the Newark factory is given later in this report.

Discharge of untreated water direct to municipal sewage plants occurs at four factories. This is a recent development and in two instances it has come about through the British Sugar Corporation agreeing to pay part of the installation costs for new municipal sewage plants. To one local body the sum paid was $67,200 and to another $75,000, and in return the two factories concerned are permitted to put their effluents into the sewers without charge provided that on any one day the load applied does not exceed 300 pounds of BOD. Under this scheme one factory has discharged 29 million gallons of waste water in one year.

At two other centers the local authorities have granted permission for the factories to put their waste waters into the sewers mainly at night, and for this service they levy a charge which at one factory has amounted to $115 for about 1 million gallons. It is required that the pH of the effluent being put into the sewer should be between six and nine.

Discharge by percolation into chalk occurs at one factory. This unusual method of disposal is of course carried out with the approval of the local authorities who are satisfied that no contamination of underground water sources is possible. Water from the Ely factory storage lagoon is purified through two trickling filters operating in series (see Table 5); the arrangement of the filters and humus tanks is shown in Figure 8.

It has also proved worthwhile to have a small aeration pond ahead of the biological filters. Six pounds/day of diammonium phosphate is fed into this pond. Approximately ½ ton of lime/day is added to the waste water before settling, as this amount will regulate the pH at 6.5 to 6.8 of the water returning to the factory.

Table 5. Water Characteristics of the Ely Factory (Great Britain).

Name of company	British Sugar Corporation Ltd.
Typical dates of campaign	September 21 to February 1
Annual beet tonnage processed	500,000
Average 24-hour tonnage processed	4,100
Source of fresh water	River Ouse
Treatment of fresh water	None
Type of diffuser	1 RT with return of pulp press water
Volume of effluent discharged/ tons of beet sliced	110 gallons
Concentration of BOD in effluent discharged	<20 ppm
Quantity of water discharged/ day	Minimum 12,000 gallons Maximum 400,000 gallons
Period of storage - days	Up to 300

The polluted water which accumulates from total re-use of flume and wash waters is purified through two trickling filters which today would cost \$110,000. The annual operating charges are \$10,000.

Water from the Newark factory storage lagoon is purified by an activated sludge biological process carried out in a Passveer Ditch. The process is described in Table 6. The water scheme at the Newark factory is shown in Figure 9. The layout of a large Passveer Ditch installed at the Wissington factory is shown in Figure 10.

At Newark milk of lime is added to the water leaving the clarifier--a sufficient amount is added to maintain the pH at about 6.0 to 7.0, and chlorine is added to the water returning to the factory.

In 1957 O. H. Phipps estimated the annual cost to the British Sugar Corporation, which was then converting from partial re-use to complete re-use of waste waters, at about \$600,000. This estimate covered the costs for the whole of the 18 factories most of which had already gone over to partial re-use.

At the Newark factory flume and waste waters are recycled and the polluted water which accumulates is purified by an activated sludge process. Condenser water is recycled after passing through a cooling tower.

The costs of installing the necessary equipment during the last few years were as follows:

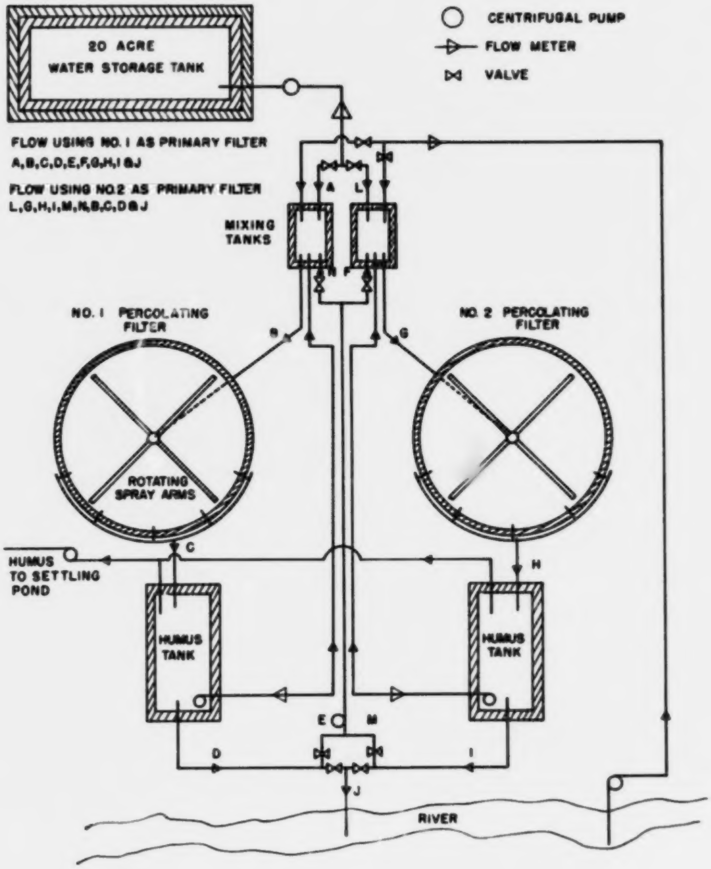
20 ACRE
WATER STORAGE TANK
CENTRIFUGAL PUMP
FLOW METER
VALVE
FLOW USING NO. 1 AS PRIMARY FILTER
A,B,C,D,E,F,G,H,I & J
FLOW USING NO.2 AS PRIMARY FILTER
L,G,H,I,M,N,B,C,D & J
A
L
MIXING TANKS
N
F
B
G
NO. 1 PERCOLATING FILTER
NO. 2 PERCOLATING FILTER
ROTATING SPRAY ARMS
C
H
HUMUS TO SETTLING POND
HUMUS TANK
HUMUS TANK
E
M
D
I
J
RIVER

Figure 8. Biological Filter Flow for Effluent Treatment, Ely Factory.

Dorr Oliver Clarifier (120 feet diameter)	$65,300
Drag screen, stone catcher, pipeliners, pumps, tank for recirculation of water in tare house	49,000
Passveer Oxidation Ditch	47,800
Chlorinator	1,600
Cooling tower	24,000
	$187,700

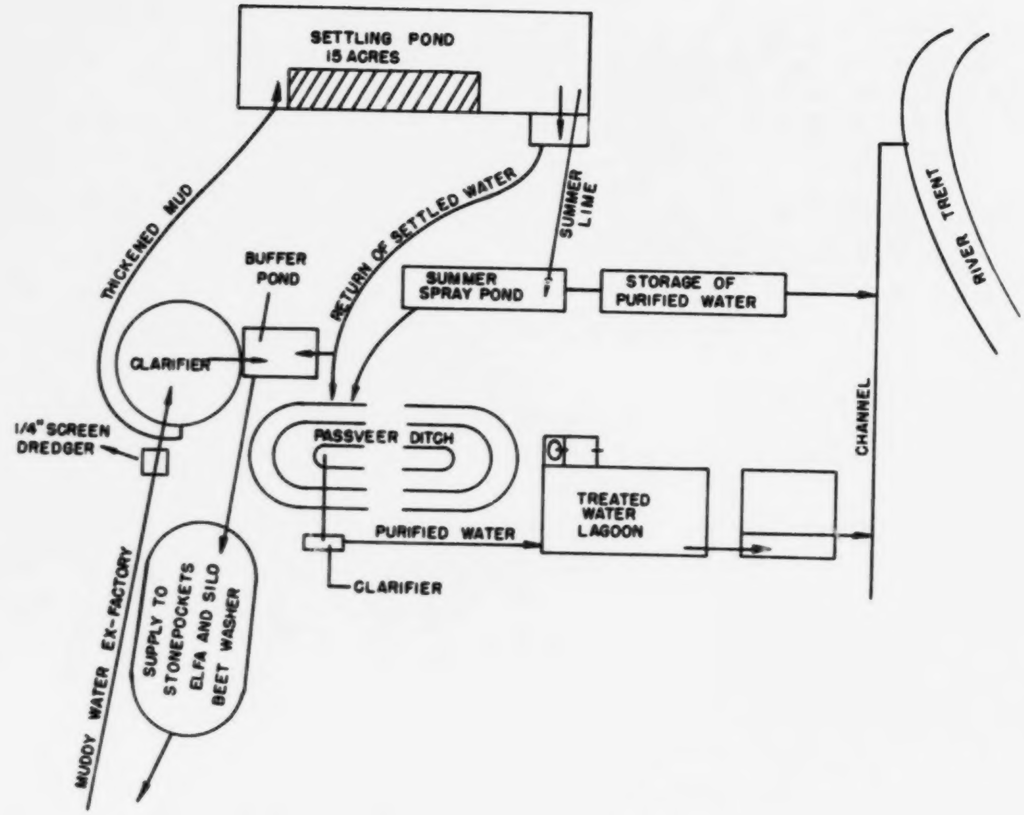
SETTLING POND
15 ACRES
THICKENED MUD
RETURN OF SETTLED WATER
SUMMER LINE
BUFFER POND
SUMMER SPRAY POND
STORAGE OF PURIFIED WATER
RIVER TRENT
CLARIFIER
CHANNEL
1/4" SCREEN DREDGER
PASSVEER DITCH
TREATED WATER LAGOON
PURIFIED WATER
CLARIFIER
MUDDY WATER EX-FACTORY
SUPPLY TO STONEPOCKETS ELFA AND SILO BEET WASHER

Figure 9. Newark Factory Waste Water Scheme.

Table 6. Water Characteristics of the Newark Factory (Great Britain).

Name of company	British Sugar Corporation Ltd.
Typical dates of campaign	September 26 to February 1
Annual beet tonnage processed	230,000
Average 24-hour tonnage processed	1,850
Source of fresh water	River Trent
Treatment of fresh water	None
Type of diffuser	Battery, operated with return of diffusion and pulp press waters
Volume of effluent discharged/ton beets sliced	117 gallons
Concentration of BOD in effluent discharged	20 ppm
Quantity of water discharged/day	Average 168,000 gallons
Quantity of stored water - gallons	27×10^6
Period of storage - days	300
BOD discharged - lbs/day	4

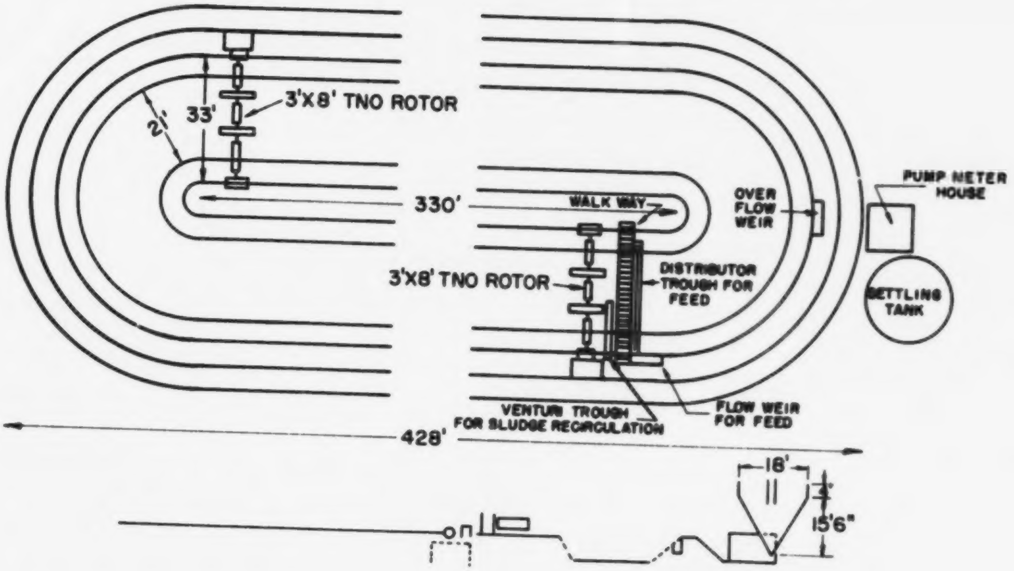
21'
33'
3'X8' TNO ROTOR
330'
WALK WAY
OVER FLOW WEIR
PUMP METER HOUSE
SETTLING TANK
3'X8' TNO ROTOR
DISTRIBUTOR TROUGH FOR FEED
VENTURI TROUGH FOR SLUDGE RECIRCULATION
FLOW WEIR FOR FEED
428'
18'
3'
15'6"

Figure 10. Wissington factory Passveer oxidation ditch.

A Passveer Oxidation Ditch has been installed at the Wissington Factory at a total cost of $96,000 which includes rotors, pumps, meters, pump house, piping, lining of ditch with 0.03 inch thick Butyl rubber sheeting and building of banks. The normal water level in the ditch will be 5 feet and the capacity at that level will be 772,000 gallons, i.e. approximately three times as great as that of the ditch at Newark. The slice is to increase from 3,000 tons/day to 7,000 tons/day over the next 3 years.

NETHERLANDS

Information relating to the Netherlands was supplied by Ir. R. Vletter whose company, N. V. Central Suiker Maatschappij processes at six factories 38 percent of the sugarbeets grown in the Netherlands.

At the present time no statutory regulations exist governing the abstraction of water or the discharge of polluted waters, but it is anticipated that by 1971 industry and local authorities will be subject to new legislation. In all probability levies will be imposed dependent upon the pollution load being discharged into National Waters, i.e. rivers or large canals, and the degree of pollution will not be assessed on BOD, but on determinations of COD and nitrogen. The population equivalent is to be calculated on the basis:

$$\text{p.e.} = \frac{\text{COD} \quad + \quad 4.57\text{N}}{180} \quad \text{(in mg/l)}$$

At the Breda factory, for which limited information on water usage is reported (see Table 7), the water flowing out from the one large settling basin has up to now been discharged without treatment into the River Mark. The settled mud is excavated yearly and used to fill up a large pit left from sand workings.

For the 1969-70 campaign a Bruckner thickener or clarifier has been installed at a cost of $415,000, which includes the necessary services for the return of water from the thickener.

Beet transport and washer waters will pass over a vibrating screen, (4 mm apertures) then to a Baum and Schreiber Classifier for the separation of stones and tails and finally to another vibrating screen. The muddy water will then go to the Bruckner thickener (72 m diameter--capacity 235,800 gallons), and from there the mud will be pumped to a lagoon. The settled water will be aerated using four floating Simcar Aerators, each of 50 hp. This study is to be carried out in conjunction with the government authorities. During these trials the authorities have agreed that press pulp water and diffusion water can be discharged directly to the river, a practice

Table 7. Water characteristics of the Breda factory (Netherlands).

Annual beet tonnage processed	350,000
Average 24-hour tonnage processed	4,500
Type of diffuser	Battery - 2. At present pulp press water and diffusion water are discarded, but in 1970 continuous diffusers will be installed and then pulp press water will be returned to the diffuser.
Daily water intake 1,000 gallons/day	9,000 + 800 for the diffusers
Condenser water	Re-used for beet flumes and then discharged
Flume + beet washer water	At present discharged to one large 30-acre basin; depth 26 feet.
Period of storage	Several months in all but gradually discharged to the River Mark.
Quantity of water discharged-gallons (up to 1969)	3,800/ton beets
BOD discharged - lbs/ton beet	6.7

which will be discontinued when a continuous diffuser is operative in the 1970-71 campaign.

It is proposed to add lime to the water coming from the thickener to adjust the pH to 8.0. Chlorine will be added to the water which is returned to the factory.

During the 1969-70 campaign Mr. de Vletter hopes to study in some detail the loss of sugar from beets during washing, using various designs of agitators in the washers. At the factory of Sass van Gent a new beet washer has been installed, and since this has been specially designed to meet the factory capacity, its performance will be examined carefully.

BELGIUM

J. Henry of the Raffinerie Tirlemontoise put forward estimates of costs for a 4,800 ton/day factory in Belgium as follows:

a. Capital cost for:	
1. Condenser water cooling tower	$200,000
2. Flume and wash waters clarification, etc.	100,000

b. Annual maintenance for:

1. Condenser system	1,000
2. Flume and wash waters system	70,000

c. Annual operating costs:

1. Power and chemicals	70,000

FRANCE

Inquiries addressed to Mr. P. Devillers and to Mr. J. Genotelle failed to elicit information on waste water matters for particular sugarbeet factories in France, but information of general interest was made available. Legislation is now operative in France which will require all French sugarbeet factories to take appropriate action to re-use waters and to avoid putting waste waters into rivers or other natural waters.

Mr. P. Devillers, Head of the Technical Services of the Syndicat National des Fabricants de Sucre, has pointed out in an article in Sucrerie Francaise that charges are to be levied (1) for water abstracted which will vary according to region and may range from 0 to 2¢ per M^3, and (2) for pollution which may cost from \$8 to \$12 per ton of BOD. Mr. Devillers estimated that a factory processing 3,000 tons of beets/day could be liable to levies amounting to between \$25,000 and \$40,000 per campaign; for the French sugarbeet industry as a whole the annual charge might amount to more than \$2,300,000. However, the industry is offered financial incentives to take the action that is necessary to avoid the penalties: the authorities are prepared to meet 50 percent of the costs of installing equipment which will both minimize water usage and also prevent the discharge of polluted effluents. This would apply only to certain installations and would not apply, for instance, to a cooling tower.

In his article Devillers lists costs for particular items which may have to be provided by, for example, a 3,000 ton/day factory:

Cooling of condenser water	$ 44,000
Mud thickener of clarifier	230,000
Pumping mud to lagoons over 2 km	41,000
Pumping lime cake 800 M	10,000

Even if the factory already had a clarifier it could nevertheless be faced with an expenditure of the order of \$95,000.

It would seem that there are sugar factories in France which still discharge diffusion and press waters, and this practice will obviously have to be stopped. In some years French factories may have an average dirt tare as high as 50 to 70 percent, and it is pointed out that this situation could be improved either by encouraging cleaning on the field or by returning soil to growers at the time of delivery. It would appear to be permissible for some French factories to put settled flume and beet washer waters on land which is permeable and has a structure such that natural purification will occur during seepage. Under these special conditions satisfactory results are said to be obtained with water having an average level of BOD of 600 ppm. It is calculated that the operation will apply to the land an amount of potassium equivalent to about 1 ton of potassium per acre per campaign. In principle, prefectorial authorization is necessary to dispose of the water in this way.

SWEDEN

Information relating to Sweden was supplied by Civ. Ing. O. Wiklund, The Research Department of the Swedish Sugar Company, Arlöv, Sweden.

A central authority, Statens Naturvard-Sverk or State Board for the Preservation of Nature, administers laws which were formulated as recently as 1967 and became effective in July, 1969. These laws require that sugarbeet factories, as well as industry, generally must have permission to abstract and dispose of water. Permission, when granted, is subject to review after four years, and in the interim period factories are required to meet whatever costs may be necessary to bring about improvements in their usage and disposal of water.

All of the Swedish sugar factories have continuous diffusers. Two of them, Kopingebro and Jordberga, are sufficiently near to the coast so that after settlement of soil in lagoons they can discharge surplus water into the sea.

Örtofta for which details are reported is not in such a situation and therefore it has established closed cycles for transport and beet wash waters, and it recycles condenser water. The quantity of water accumulated is about 87 percent on beet. This high proportion is in accord with the BOD of the surplus water being about 1,300 ppm. The main course of entry into the factory, apart from that brought in with the beet, is through the cooling systems, and part of the water from the cooling tower passes into the transport water having been used to spray the beets after they emerge from the washer. No chlorine is added to the water going to the cooling tower, but in amounts which range from 213g to 77g/ton beet at Örtofta and Kopingebro, respectively, chlorine is added to the water returning to the factory from the Passavant Thickener.

After separation of sand and mud, the surplus water is stored in two ponds occupying an area of about 19 acres. The depth of water in these ponds is about 15.5 feet so that they are highly anaerobic. From these deep ponds the water passes into three shallow aeration ponds

(3.3 feet deep), where through spraying and by the action of surface aerators, the BOD is brought down to about 45 ppm, at which level discharge to the river is permissible.

The Research Department of the Swedish Sugar Company has carried out extensive studies on waste waters with a pilot scale activated sludge system, and the results are to be found in work reported by Wiklund, et al. (11). Confirming the experiences of Ameln it was found to be beneficial to add to factory waste waters ammonium salts and disodium phosphate ($Na_2 HPO_4$). No Swedish factory has yet installed an activated sludge plant. Mr. Wiklund expressed considerable interest in a paper, "The Anaerobic Filter for Waste Treatment", presented by J.C. Young and P. L. McCarty of Stanford University Civil Engineering Department to the 22nd Conference (1967) on Industrial Waste. When a rock-filled bed, similar to an aerobic trickling filter was fed from below, the Stanford investigators obtained good removal of organic matter and an effluent practically free from suspended solids. To obtain an effluent free from sludge is an attractive aim, but it must be pointed out that if the anaerobic process were applied to sugarbeet factory waste waters, very appreciable quantities of sulphide would be formed by the reduction of sulphate.

At the Örtofta factory, water from the three mud ponds, each of which is filled in turn, passes to a large lagoon where anaerobic conditions prevail. (See Table 8). Finally, 98 percent elimination of BOD is accomplished by aeration through spraying and through mechanical agitation in three shallow ponds.

A schematic representation of the waste water system is attached (Figure 11). By agreement with a farmer soil from the mud ponds is pumped to a meadow for ultimate reclamation.

Condenser water is cooled by forced ventilation in a tower. A portion of the condenser water is used as a spray on the beets coming from the washer, and this passes into the beet transport water.

Lime sludge is conveyed without addition of water by means of a pump and air injection applied intermittently into the pipeline carrying the thickened mud.

At the Örtofta Factory the estimated cost of converting to re-use of waste water was given as $600,000 with annual operating costs as $9,000.

SWITZERLAND

Information on the scheme shown in Figure 12 was kindly supplied by the Aarberg factory manager, Civ. el. Ing. P. Reichen.

Table 8. Water Characteristics of the Örtofta Factory (Sweden).

Name of company	Svenska Sockerfabriks AB
Typical dates of campaign	October 2 to December 23
Annual beet tonnage processed	409,800 metric tons
Average 24-hour tonnage processed	5,080 metric tons
Source of fresh water	River Kävlinge
Gross fresh water intake 1,000 gallons/day	786
Treatment before use	None[1]
Type of diffuser	2 DDS continuous types with total recycling of pulp press water
Estimated cost of waste water treatment facilities	$600,000
Annual operating costs	$ 9,000
Volume of effluent discharged/ ton beet sliced	233 gallons
Amount of BOD discharged/ ton beet sliced	0.088 pounds
Concentration of BOD in effluent discharged	45 ppm
Volume of waste water stored - gallons	91.7×10^5
Length of storage	Approximately 260 days
Period of discharge	112 days, i.e. from late May to September
Volume of water discharged/day	851,500 gallons

The Aarberg factory has an average daily slice of 2,880 tons and processes about 250,000 tons beet per campaign. Dirt tare averages between 10 and 12 percent but may at times reach 40 percent.

Transport and wash waters are fed into a rectangular shaped von Roll (Swiss) clarifier having two sections through which water flows in parallel. The clarifier has a capacity of 325,000 gallons and cost the equivalent of $150,000 which included all concrete work, machinery, pumps and a control building.

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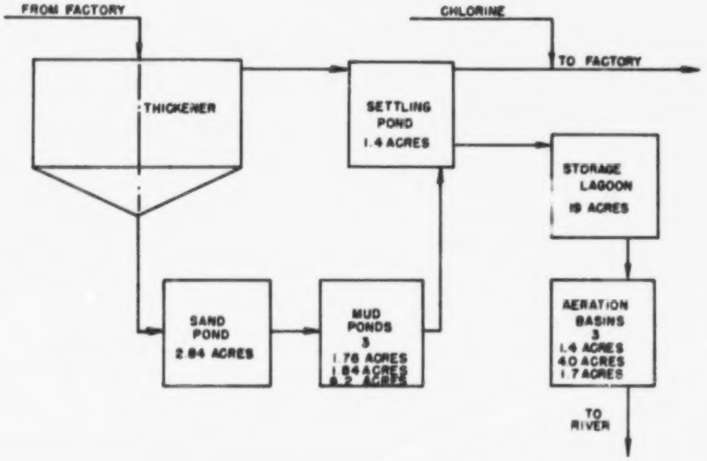
[1] Flume and beet washer waters are screened to separate small pieces of beet, and mud is separated in a Passavant clarifier. Before return to the factory, chlorine is added to the water.


FROM FACTORY
CHLORINE
TO FACTORY
THICKENER
SETTLING POND 1.4 ACRES
STORAGE LAGOON 19 ACRES
SAND POND 2.84 ACRES
MUD PONDS 3 1.76 ACRES 1.84 ACRES 8.2 ACRES
AERATION BASINS 3 1.4 ACRES 4.0 ACRES 1.7 ACRES
TO RIVER

WASTE WATER SCHEME, ÖRTOFTA

STORAGE LAGOON	AREA ACRES	DEPTH FEET	VOLUME 10^6 GAL
	19	15.5	93.6
AERATION BASINS	1.4	3.5	1.5
	4.0	3.5	4.2
	1.7	3.5	1.8

Figure 11. Waste Water Scheme, Örtofta.

The settled mud is pushed to one end of the clarifier from where it is transferred to a bunker. Here it is mixed with lime sludge (which is transferred from the rotary filters without water addition), and together the soil and sludge are pumped at a rate of about 30,000 gallons/hour through a pipe of 150 mm diameter to mud ponds 1.5 to 2.5 km distant from the factory.

The addition of the lime cake together with a small amount of lime maintains the water in the clarifier at a pH of 11 to 12. The lime which is used is simply that which accompanies the sand and very fine waste lime that are separated from the milk of lime after it leaves the slaker. The overflow from the clarifier goes to a basin of 208,000 gallons capacity, and from these it is pumped back to the flume and wash water systems. The BOD of the water builds up to about 1,800 ppm, but because the pH is always kept at a high level, no unpleasant smell develops. De-scaling of pumps is necessary from time to time.

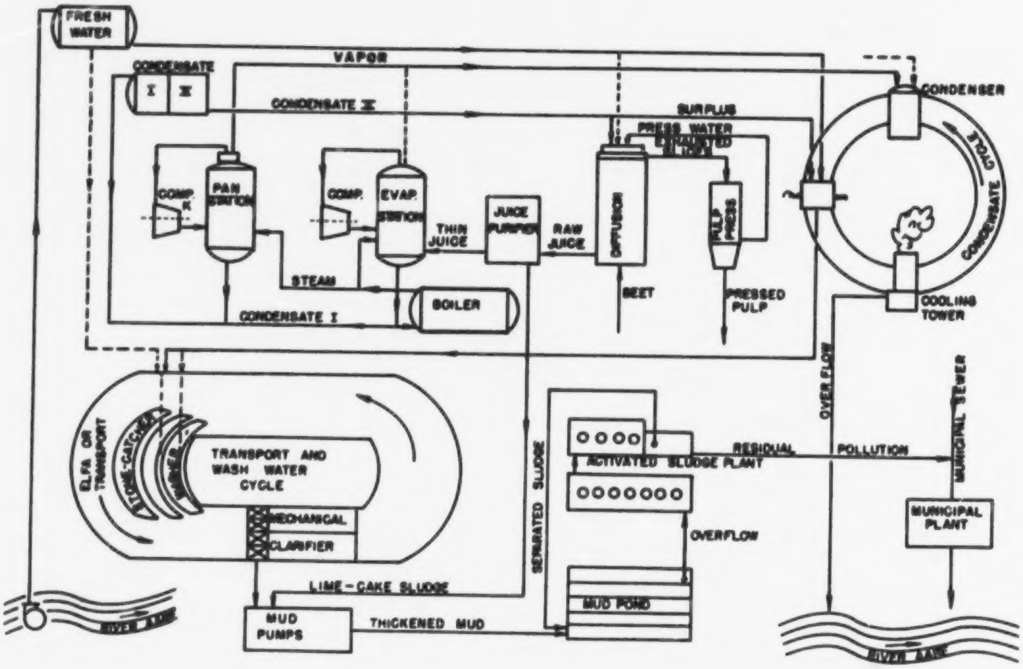

FRESH WATER
CONDENSATE
I
II
VAPOR
CONDENSATE II
COMP. K
PAN STATION
COMP.
EVAP. STATION
THIN JUICE
JUICE PURIFIER
RAW JUICE
DIFFUSION
SURPLUS
PRESS WATER
EXHAUSTED SLICES
PULP PRESS
CONDENSER
CONDENSATE CYCLE
STEAM
BOILER
CONDENSATE I
BEET
PRESSED PULP
COOLING TOWER
OVERFLOW
MUNICIPAL SEWER
ELFA OR TRANSPORT
STONE CATCHER
WASHER
TRANSPORT AND WASH WATER CYCLE
MECHANICAL
CLARIFIER
SEPARATED SLUDGE
ACTIVATED SLUDGE PLANT
RESIDUAL
POLLUTION
MUNICIPAL PLANT
OVERFLOW
LIME-CAKE SLUDGE
MUD PUMPS
THICKENED MUD
MUD POND
RIVER AARE
RIVER AARE

Figure 12. Aarberg Factory Water Scheme.

Aarberg factory is situated in a region where land is scarce and what is available is very expensive, and under these circumstances the factory cannot store its waste water on a large scale. Fortunately the owners of land situated 1.5 to 2.5 km from the factory are prepared to allow soil to be deposited on certain areas provided that these are subsequently drained and quickly rendered suitable for reclamation for agricultural purposes. It is interesting to note that the subsoil in the pond areas is gravel, and after the factory had dug out the ponds for the reception of soil, it was obliged to line them with clay so as to avoid the possibility of contaminating the supplies of domestic water which are pumped from wells nearby.

Water free from soil is pumped from the settling ponds to an activated sludge plant where it undergoes substantial purification (at times as much as 96 to 98 percent of the BOD is removed), and after separation of sludge, the treated water is piped about 0.5 km to another activated sludge plant belonging to the communities of Aarberg and Lyss. Here the water together with local sewage is purified and rendered suitable for discharge into the river, the Alte Aare. Having contributed the substantial sum of $296,000 toward the cost of the municipal plant, the sugar factory pays only a nominal charge for the privilege of putting its final effluent into the sewage treatment plant.

The activated sludge plant belonging to the factory cost $342,000 and is comprised of three concrete basins, two for aerators and one for clarification by settling. The largest aeration basin, measuring 13.5 x 104 x 2 meters, is fitted with seven Lurgi Vortair aerators, each capable of introducing about 1 ton of oxygen per day into the water.

Sludge and water pass from the large aerating basin to a similar basin in parallel with the first and containing four Vortair aerators. From here water and sludge pass to a settling basin measuring 8 x 43 x 2 meters and having a central channel in the bottom from where the excess sludge which settles out is pumped away to the soil ponds. Provision is also made for sludge to be returned to the aeration basins. Purified water which overflows from the clarifier is conveyed to the municipal sewage treatment plant. It is aimed to reduce the BOD of the water in the factory plant to about the level of normal domestic waste, but even if at times this is not achieved, nevertheless, the municipal plant has the necessary capacity.

Additions of diammonium phosphate and urea are made to the ingoing waste water at the factory plant since these are found to enhance the activity of the sludge. The need for phosphate and for nitrogen in activated sludge systems has frequently been observed, and it is also common experience that active sludge is rather slow to develop in sugar factory waste waters. This difficulty has been overcome at Aarberg by starting the plant about a week before the beginning of the campaign, the aeration basins having been filled with a dilute solution made from between 8 and 10 tons of molasses.

SUMMARY

It is evident that some sugarbeet factories have succeeded when working with a closed system in reducing the quantity of waste water that has to be stored to between 30 percent and 40 percent on beet. To do this they have adopted certain measures which include:

1. Recycling of flume and beet washer water after separation of soil.
2. Recycling of condenser water through a cooling tower.
3. Returning pulp press water to the diffuser and using hot condensate, preferably after neutralizing with acid as make-up water for diffusion.
4. Transporting lime sludge out of the factory without addition of water to the lime cake.
5. Returning to the river, from which the factory receives its water, all uncontaminated cooling water as, for example, that used for turbines, pumps, etc.

If a factory slices 200,000 tons of beets and stores a quantity of waste water equivalent to 30 percent on beet, then it will require a lagoon covering about 15 acres if the depth of water is not to be more than 3 to 4 feet; this being the condition under which natural purification of the water will proceed most rapidly.

It has been established at factories in England and Germany that sugarbeet factory waste water can be purified satisfactorily by biological processes carried out either on trickling filters or by aeration in the presence of activated sludge. The resultant effluent, having a BOD of 20 ppm or less, is suitable for discharge to rivers or other natural sources of water.

Evidence obtained from different countries confirms that to treat waste water by either of the biological digestion processes is costly, and for financial as well as operational reasons it seems to be worthwhile for a factory to seek permission to feed its waste water, either with or without partial purification, into a public sewage plant. An approach by the factory to the municipality seems most likely to succeed at a time when the latter is contemplating installing a new plant, and the factory offers to defray a substantial part of the cost. Under these conditions the factory may be given the right to feed its waste into the public sewer without further charge.

When it is possible to store a relatively large volume of water having a low concentration of BOD, then purification can be carried out satisfactorily, as at Örtofta, simply by energetic aeration.

Where no storage space is available, then the system of aeration followed by discharge of the effluent to a municipal sewage plant, as developed at Aarberg, is a practice worthy of consideration.

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TABLE 9

Summary of Factory Capacities and Fresh Water Usage

Factory	Slicing ton/day	Molasses ton/day	Gross[3] Water Intake GPDx10^3	Beet Flumes	Barometric Condensers	Diffuser Supply	Lime Mud	Steffen (Dil.)	Other
Betteravia, California	4,800	-	3,954	0	2,246	1,420	0	-	288
Brawley, California	6,500	-	3,900	0	2,800	860	240	-	-
Clarksburg, California	3,000	-	8,000	3070	4,500	0	0	-	430
Hamilton City, California	1,875	-[1]	4,773	1,980	587	138	75	-	2,068[1]
Manteca, California	4,000	-	6,300	0	1,750	150	175	-	-
Mendota, California	3,900	220	4,132	1,100	2,500	0	30	370	132
Santa Ana, California	1,851	96	2,270	0	2,000[2]	0	70[2]	200[2]	-
Spreckels, California	6,000	350	9,505	150	3,310	0	0	700	?
Tracy, California	2,600	123	3,500	2,500	some	250	150	600	
Woodland, California	3,300	180	6,900	0	6,900	?	0	?	-
Brighton, Colorado	2,178	-	4,070	0	3,872	0	198	-	-

[1] Ion-Exchange

[2] Estimated by Author

[3] Gross water intake does not always total the sum of individual uses since condenser water is considered fresh water at some factories.

TABLE 9 (continued)

Factory	Slicing ton/day	Molasses ton/day	Gross Water Intake GPDx10^3	Beet Flumes	Barometric Condensers	Diffuser Supply	Lime Mud	Steffen (Dil.)	Other
Delta, Colorado	1,500	50	6,000	0	3,000	360	1	120	-
Eaton, Colorado	2,000	-	3,268	0	3,116	0	152	-	-
Fort Morgan, Colorado	3,632	187	12,000	7,990	2,203	194	272	249	-
Greeley, Colorado	2,145	-	6,050	0	5,121	0	202	-	727
Longmont, Colorado	3,307	189	11,000	0	9,000	432	216	432	-
Loveland, Colorado	3,688	190	13,070	0	11,000	670	710	432	258
Ovid, Colorado	2,617	-	11,692	4,864	5,820	812	58	-	-
Rocky Ford, Colorado	3,024	94	8,000	800	5,818	800	240	342	-
Sterling, Colorado	2,435	-	6,100	1,525	4,179	151	62	-	183
Bay City, Michigan	3,500	-	8,200	3,000	5,000	0	0	-	200
Caro, Michigan	1,835	-	4,450	1,700	2,400	250	100	-	-
Carrollton, Michigan	1,814	-	4,600	1,650	2,600	250	100	-	-

TABLE 9 (continued)

Factory	Slicing ton/day	Molasses ton/day	Gross Water Intake GPDx10^3	Beet Flumes	Barometric Condensers	Diffuser Supply	Lime Mud	Steffen (Dil.)	Other
Croswell, Michigan	1,275	-	3,250[4]	75	3,000	0	150	-	25
Sebewaing, Michigan	1,900	-	4,000	1,200	2,450	250	100	-	-
Idaho Falls, Idaho	4,200	125	3,600	0	2,542	648	86	180	144
Mini-Cassia, Idaho	6,545	-	8,640	0	7,780			-	570
Nampa, Idaho	4,824	-	8,640	0	7,776	0	0	-	764
Twin Falls, Idaho	4,594	226	10,800	0	9,720	0	0	270	810
Chaska, Minnesota	2,000	-	4,000	0	3,500	0	36	-	464
Crookston, Minnesota	3,494	-	5,800	0	5,800	0	0	0	0
East Grand Forks, Minnesota	2,750		5,000	500	4,500	0	0	-	0
Moorhead, Minnesota	3,585	-	4,328	0	4,328	0	0	-	-
Bayard, Nebraska	2,174	-	8,290	0	6,500	0	3	-	-
Gering, Nebraska	2,250	100	5,000	2,500	2,476	0	1	13	-

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[4] Pump capacity. Actual flow approximately 1800 gpm.

TABLE 9 (continued)

Factory	Slicing ton/day	Molasses ton/day	Gross Water Intake GPDx10^3	Beet Flumes	Barometric Condensers	Diffuser Supply	Lime Mud	Steffen (Dil.)	Other
Mitchell, Nebraska	2,184	-	8,500	0	6,500	-	215	-	?
Scottsbluff, Nebraska	3,366	175	12,000	2,500	7,750	0	5	240	-
Billings, Montana	4,250	180	18,000	10,000	3,000	170	110	128	-
Hardin, Montana	1,700	-	4,000	0	4,000	0	0	-	-
Sidney, Montana	2,500	-	6,867	0	6,867	0	0	-	-
Findlay, Ohio	1,500	-	570	0	520	50	-	-	-
Fremont, Ohio	1,980	-	8,650	0	8,600	50	0	-	-
Ottawa, Ohio	1,700	-	2,000	0	2,000	0	0	-	-
Garland, Utah	2,550	110	8,712	0	8,014	288	86	180	144
Lewiston, Utah	1,822	98	4,640	0	4,435	0	0	0	490
West Jordan, Utah	1,600	-	7,200	?	7,000	?	56	-	144
Lovell, Wyoming	2,183	-	5,000	2,248	1,552	0	200	-	-
Torrington, Wyoming	3,034	139	7,630	2,290	3,816	0	190	19	-

TABLE 9 (continued)

Factory	Slicing ton/day	Molasses ton/day	Gross Water Intake GPDx10^3	Beet Flumes	Barometric Condensers	Diffuser Supply	Lime Mud	Steffen (Dil.)	Other
Worland, Wyoming	1,600	76	7,500	4,000	2,000	500	100	100	800
Toppenish, Washington	3,800	-	8,640	0	7,906	518	0	-	216
Moses Lake, Washington	6,450	225	3,715	0	2,225	922	86	324	158
Chandler, Arizona	4,000	-	1,883	0	1,250	0	33	-	-
Mason City, Iowa	1,881	-	7,340	1720	5,370	0	250	-	-
Goodland, Kansas	2,609	-	853	0	811	0	0	-	42
Easton, Maine	4,000[5]	-	2,000	500	1,200	300	0	-	-
Drayton, North Dakota	3,915	-	8,794	0	8,500	0	0	-	294
Nyssa, Oregon	6,605	204	14,400	0	11,520	0		357	2,523
Hereford, Texas	6,493	-	1,400	0	some	0	some	-	-

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[5] Estimated from incomplete oral report

TABLE 10

Water use and Re-Use Per Ton Beets

Factory	Raw Water Intake Gal/Ton Beets	Gross Water Use, Gallons Per Ton Beets					
		Fluming	Condensers and Cooling	Diffuser Supply	Lime Mud	Steffen Dilution	Total
Betteravia, California	850	1,430	2,080	190	32	-	3,732
Brawley, California	600	1,810	1,270	223	76	-	3,379
Clarksburg, California	2,666	2,440	1,500	333[1]	7	-	4,228
Hamilton City, California	2,540	2,060	2,760	539	40	1,100[1]	5,339
Manteca, California	1,600	1,500	1,250	240	44	-	3,034
Mendota, California	1,060	2,560	2,000	250	18	95	4,925
Santa Ana, California	1,220	X	X	X	X	X	X[2]
Spreckels, California	1,600	1,100	3,000	295	47	120	4,562
Tracy, California	1,350	1,000	2,120	270	60	231	3,680
Woodland, California	2,100	1,300	2,100	240	X X	124?[3]	2,800

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[1] Ion-exchange regeneration omitted from total.

[2] "X" entry indicates information was not supplied.

[3] "?" indicates the entry is questioned and was not verified.

TABLE 10 (continued)

Factory	Raw Water Intake Gal/Ton Beets	Gross Water Use, Gallons Per Ton Beets					
		Fluming	Condensers and Cooling	Diffuser Supply	Lime Mud	Steffen Dilution	Total
Brighton, Colorado	1,870	2,640	3,100	290	90	-	6,120
Delta, Colorado	4,000	2,000	2,000	240	66	80	4,400
Eaton, Colorado	1,620	2,525	2,160	284	76	-	5,045
Fort Morgan, Colorado	3,300	2,200	1,100?	190	80	70	3,660?
Greeley, Colorado	2,800	2,390	1,720	240	100	-	4,450
Longmont, Colorado	3,300	2,500	2,720	260	65	130	5,545
Loveland, Colorado	3,560	2,620	3,040	360	190	117	6,327
Ovid, Colorado	4,090	3,350	2,220	284	20	-	5,870
Rocky Ford, Colorado	2,640	2,640	2,000	300?	80	114	5,134
Sterling, Colorado	2,540	2,880	1,720	238	20	-	4,800
Bay City, Michigan	2,350	1,720	1,430	510	X	-	3,660
Caro, Michigan	2,420	3,270	1,310	408	50	-	4,978
Carrollton, Michigan	2,480	3,170	1,430	344	110	-	5,054
Croswell, Michigan	2,500	2,500	2,360	300	120	-	5,280

TABLE 10 (continued)

Factory	Raw Water Intake Gal/Ton Beets	Gross Water Use, Gallons Per Ton Beets					
		Fluming	Condensers and Cooling	Diffuser Supply	Lime Mud	Steffen Dilution	Total
Sebewaing, Michigan	2,100[3]	2,610?	2,000?	300?	50?	-	4,960?
Idaho Falls, Idaho	860	1,710	2,230	223	20	43	4,226
Mini-Cassia, Idaho	1,320	1,320	2,215	170	51	-	3,700
Nampa, Idaho	1,800	1,790	1,610	300?	50	-	3,750
Twin Falls, Idaho	2,350	1,300	2,320	225	63	57?	3,965
Chaska, Minnesota	2,000	1,500	1,750	240	27	-	3,527
Crookston, Minnesota	1,650	1,888	1,660	220?	9	-	3,777
East Grand Forks, Minnesota	1,890	1,640	1,820	290	4	-	3,754
Moorhead, Minnesota	1,210	1,220	1,210	290	54	-	2,774
Bayard, Nebraska	1,800	2,760	3,000	240	2	-	6,000
Gering, Nebraska	2,220	2,210	1,100?	240	--	6	4,316
Mitchell, Nebraska	3,900	2,000	3,000	220	100	-	5,400
Scottsbluff, Nebraska	3,600	1,500	2,300	330	16	72	4,218

TABLE 10 (continued)

Factory	Raw Water Intake Gal/Ton Beets	Gross Water Use, Gallons Per Ton Beets					
		Fluming	Condensers and Cooling	Diffuser Supply	Lime Mud	Steffen Dilution	Total
Billings, Montana	4,200	2,825		220	30	30?	
Hardin, Montana	2,360	2,060	2,360	324	60	-	4,804
Sidney, Montana	2,750	2,650	2,750	288	50?	-	5,740
Findlay, Ohio	380	4,000	4,500	170	20	-	9,690
Fremont, Ohio	4,300	3,530	4,340	160?	20	-	8,150
Ottawa, Ohio	1,180	1,170	2,250		7	-	3,600
Garland, Utah	3,400	2,820	3,400	254	130	70	6,604
Lewiston, Utah	2,530	4,410	2,270	239	X	220	7,140
West Jordan, Utah	4,400	4,500	4,400	945	70	-	9,915
Lovell, Wyoming	2,300	1,630	2,170	305	100	-	4,215
Torrington, Wyoming	2,500	1,480	1,270	296	63	6	3,115
Worland, Wyoming	4,690	3,800	1,900	470	60	60	6,290
Toppenish, Washington	2,280	2,084	2,080	380[4]	23	-	4,567

[4] Includes pulp transport water.

TABLE 10 (continued)

Factory	Raw Water Intake Gal/Ton Beets	Gross Water Use, Gallons Per Ton Beets					
		Fluming	Condensers and Cooling	Diffuser Supply	Lime Mud	Steffen Dilution	Total
Moses Lake, Washington	580	2,340	2,000	201	13	50	4,604
Chandler, Arizona	470	1,650	2,060	190	8	-	3,908
Mason City, Iowa	3,900	4,440	2,855	314	13	-	7,622
Goodland, Kansas	328	4,500	3,320	263	55	-	8,738
Easton, Maine[2]	500	X	X	X	X	-	X
Drayton, North Dakota	2,250	2,440	2,170	197?	63	-	4,870
Nyssa Oregon	2,190	2,180	1,750	210	58	54	4,252
Hereford, Texas	215	1,330	1,375	300?	X	-	3,000

TABLE 11

Waste Discharged to Stream Per Ton of Beets; Cost of Disposal Facilities

Factory	Effluent to Streams Per Ton Beets Sliced		Waste Disposal Facilities	
	Gallons	Lb. BOD	Capital Cost	Annual Operating Cost
Betteravia, California (pulp operation, Sinton and Brown)	-	8.0 est.	$ -	$ -
Betteravia, California	0	0	-	-
Brawley, California	373	0.6	250,000	1,000
Clarksburg, California	1,099	2.2	250,000	?
Hamilton City, California	0	0	-	-
Manteca, California	0	0	200,000	20,000
Mendota, California	0	0	250,000	20,000
Santa Ana, California	0	0	-	-
Spreckels, California	0	0	700,000	15,000
Tracy, California	1,260	0.5	-	-
Woodland, California	0	0	200,000	15,000
Brighton, Colorado	0	0	300,000	54,000
Delta, Colorado	400	5.0	63,700	13,000
Eaton, Colorado	760	-	160,000	26,000
Fort Morgan, Colorado	2,200	5.0	150,000	3,500
Greeley, Colorado	2,400	3.1	182,000	10,000
Longmont, Colorado	890	0.3	260,000	40,000
Loveland, Colorado	2,660	3.1	-	-
Loveland, Colorado (planned 1970)	-	0.5	500,000	50,000
Ovid, Colorado	3,450	5.0	100,000	3,[illegible]00

TABLE 11 (continued)

Factory	Effluent to Streams Per Ton Beets Sliced		Waste Disposal Facilities	
	Gallons	Lb. BOD	Total Cost	Annual Operating Cost
Ovid, Colorado (planned 1970)	?	low	$ 250,000	$ 25,000
Rocky Ford, Colorado	2,330	-	200,000	?
Sterling, Colorado	2,415	6.0	-	1,500
Bay City, Michigan	1,140	1.0	150,000	15,000
Caro, Michigan	2,300	4.0	-	-
Carrollton, Michigan	1,800	3.5	150,000	15,000
Croswell, Michigan	2,500	4.0	-	-
Sebewaing	2,000 est.	3.5 est.	100,000 est.	5,000 est.
Idaho Falls, Idaho	1,900	4.0	200,000	3,000
Mini-Cassia, Idaho	0	0	689,000	20,000
Nampa, Idaho	1,610	3.2	650,000	20,000
Twin Falls, Idaho	2,185	15.6	70,000	2,000
Chaska, Minnesota	0	0	250,000	12,000
Crookston, Minnesota	658	6.3	300,000	25,000
East Grand Forks, Minnesota	1,800	5.0	500,000	50,000
Moorhead, Minnesota	741	3.5	-	-
Bayard, Nebraska	2,890	5.0	37,000	4,350
Gering, Nebraska	2,220	5.0	52,000	5,000
Mitchell, Nebraska	500	4.3	30,000	3,300
Scottsbluff, Nebraska	1,367	7.0	40,000	3,000
Scottsbluff, Nebraska (planned 1970)	-	2.0	?	?

TABLE 11 (continued)

Factory	Effluent to Streams Per Ton Beets Sliced		Waste Disposal Facilities	
	Gallons	Lb. BOD	Total Cost	Annual Operating Cost
Billings, Montana	2,600	7.0	$ 40,000	$ 3,000
Hardin, Montana	1,750	2.6	10,000	5,000
Sidney, Montana	2,758	7.7	67,000	3,500
Findlay, Ohio	0	0	300,000	30,000
Fremont, Ohio	4,200	2.5	450,000	35,000
Ottawa, Ohio	1,500	1.1	-	20,000+
Garland, Utah	3,350	4.0	125,000	1,000
Lewiston, Utah	1,756	3.0	162,000	5,000
West Jordan, Utah	4,235	4.0	250,000	1,000
Lovell, Wyoming	2,010	9.0	57,000	?
Torrington, Wyoming	1,483	3.8	-	-
Worland, Wyoming	0	0	-	-
Toppenish, Washington	1,906	4.0	200,000	3,000
Moses Lake, Washington	0	0	300,000	2,000
Chandler, Arizona	0	0	450,000	20,000
Mason City, Iowa	3,396	6.9	150,000	25,000
Goodland, Kansas	0	0	448,000	21,000
Easton, Maine	little	little	5,000,000	100,000
Drayton, North Dakota	2,000	14.0	-	-
Nyssa, Oregon	1,730	5.7	338,000	40,000
Hereford, Texas	0	0	1-2 million	?

TABLE 12

Beet Sugar Factories Included In This Survey

1. The Amalgamated Sugar Company
First Security Bank Building
P. O. Box 1520
Ogden, Utah 84402

Factories at: Mini-Cassia, Idaho (Rupert)
Nampa, Idaho
Twin Falls, Idaho
Nyssa, Oregon
Lewiston, Utah

2. American Crystal Sugar Company
Boston Building
Denver, Colorado 80202

Factories at: Clarksburg, California
Rocky Ford, Colorado
Mason City, Iowa
Chaska, Minnesota
Crookston, Minnesota
East Grand Forks, Minnesota
Moorhead, Minnesota
Drayton, North Dakota

3. Buckeye Sugars, Inc.
Ottawa, Ohio 45875

Factory at: Ottawa, Chio

4. The Great Western Sugar Company
Sugar Building
P. O. Box 5308
Denver, Colorado 80217

Factories at: Brighton, Colorado
Eaton, Colorado
Fort Morgan, Colorado
Greeley, Colorado
Johnstown, Colorado - Molasses Plant
Johnstown, Colorado - Monosodium Glutamate Plant
Longmont, Colorado
Loveland, Colorado

TABLE 12 (continued)

Ovid, Colorado
Sterling, Colorado
Goodland, Kansas (Kemp)
Billings, Montana
Bayard, Nebraska
Gering, Nebraska
Mitchell, Nebraska
Scottsbluff, Nebraska
Lovell, Wyoming

5. Holly Sugar Corporation
Holly Sugar Building
P. O. Box 1052
Colorado Springs, Colorado 80901

Factories at: Brawley, California (Carlton)
Hamilton City, California
Santa Ana, California (Dyer)
Tracy, California
Delta, Colorado
Hardin, Montana
Sidney, Montana
Hereford, Texas (Shoup)
Torrington, Wyoming
Worland, Wyoming

6. Michigan Sugar Company
Second National Bank Building
P. O. Box 1091
Saginaw, Michigan 48606

Factories at: Caro, Michigan
Carrollton, Michigan
Croswell, Michigan
Sebewaing, Michigan

7. Monitor Sugar Company
2600 South Euclid Avenue
Bay City, Michigan 48706

Factory at: Bay City, Michigan

TABLE 12 (continued)

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8. Northern Ohio Sugar Company
(wholly owned subsidiary of The Great Western Sugar Company)
Sugar Building
Denver, Colorado 80217
(operating offices - Fremont, Ohio)

Factories at: Findlay, Ohio
Fremont, Ohio

9. Spreckels Sugar Company
Two Pine Street
San Francisco, California 94111

Factories at: Chandler, Arizona
Manteca, California
Mendota, California
Spreckels, California
Woodland, California

10. Union Sugar, Consolidated Foods Corporation
230 California Street
San Francisco, California 94111

Factory at: Betteravia, California

11. Utah-Idaho Sugar Company
200 Beneficial Life Building
47 West South Temple (P. O. Box 2010)
Salt Lake City, Utah 84110

Factories at: Idaho Falls, Idaho
Garland, Utah
West Jordan, Utah
Moses Lake, Washington
Toppenish, Washington

WATER USE, RE-USE AND DISPOSAL

The Amalgamated Sugar Company at Lewiston, Utah

A. Beets sliced, tons/day:--1822; Molasses worked, tons/day:--98; Gross raw water intake:--4640 x 10^3 (US gal/day); Source: Bear River--100%.

B. Flow sheet type II. Modifications: Steffen waste to separate lagoon. All wastes held until spring. Some reduction in BOD. Controlled discharge during high river flows.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	3600					
Condensers and Cooling	4150	0	4435		288		
Diffuser Supply	0	435					
Lime Mud	0						X
Steffen Dilution	0					220	
Miscellaneous	490						

D. Waste Treatment

1. Flume and general waste screened, discharge not direct, to holding facilities (one pond--20 acres, 10 ft. deep), 70 days retention, then to river during high water flow in the spring. BOD in waste to river 370-910 ppm. Sanitary sewer to septic tank.
2. Lime mud discharged to ponds (one pond--5.18 acres), overflow discharged direct but volume controlled.
3. Condenser water to flumes. Discharged direct--none.

Note: Steffen waste to separate pond. Held until BOD is reduced and discharged when river is high.

Comment: Volume flume water discharged to river 3.2 x 10^6 gal/day. BOD in waste discharged 550 lb/day.

WATER USE, RE-USE AND DISPOSAL
The Amalgamated Sugar Company at Rupert, Idaho

A. Beets sliced, tons/day:--6545; Total campaign:--799400; Gross water intake:--8650 (GPD x 10^3); Source: Wells and drainage ditch (creek); Water Treatment: 90% given "boiler water" treatment.

B. Flow sheet type IV. Modifications: Excess condenser water to stream, otherwise completely enclosed system. Very elaborate settling system. No discharge to stream.

C. In-Plant Water Flows (GPD x 10^3).

	Raw Water Use	Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	8210					
Condensers	7780	7200	4750		430		
Diffuser Supply	0	690					
Lime Mud	0						
Steffen Dilution	-	-	-	-	-	-	-
Gas Washer	570						

D. Waste Treatment
1. Flume water screened, then hydroseparator (2- 22' diam.) underflow to mud pond (6.9 acres - 6 ft. deep), one day retention; overflow to clarifier - 130' diam. by 12' deep, clear overflow to second holding basin - 130' diam. x 12' deep which is supply to fluming system. Completely enclosed system. Milk of lime added before hydroseparator - about 19 tons CaO/day.
2. Condenser water cooled in tower (5000 gal/min.); 2800 GPM to pan condensers, remainder to creek. Temperature 30° C. Makeup water pumped from creek.
3. Lime mud to separate pond, 26 acres, no overflow; hence no BOD to creek.

Note: Sanitary sewer to septic tank.

WATER USE, RE-USE AND DISPOSAL

The Amalgamated Sugar Company at Twin Falls, Idaho

A. Beets sliced, tons/day:--4594; Molasses worked, tons/day:--226; Gross water intake:--10800 x 10^3 (US gal/day); Source: One well, river, 5% of water treated--Nalco.

B. Flow sheet type II. Modifications: Many. Flume water and general wastes screened, then to river--no ponds. Steffen waste evaporated.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	0					
Condensers	9720	0	5910		537		288
Diffuser Supply	0	537					
Lime Mud	0	0					
Steffen Dilution	270	0					
Miscellaneous	810						

D. Waste Treatment

1. Flume and general waste: screened, discharged direct to river--no ponds. Volume of waste 10.8 million gal/day, BOD content 72,400 lbs/day.
2. Lime mud to pond, one. Overflow of settled liquor direct to river - 302,000 gal/day. BOD content unknown.
3. Condenser water to flumes, beet washers, sprays and dilution lime mud.
4. Pulp and pulp press water completely recycled to diffuser.
5. Steffen waste evaporated and dried on pulp 100%.
6. Floor drainage to main sewer (432,000) gal/day), main sewer to general waste.
7. Sanitary sewer to septic tank.

E. Comments: Total effluent 2185 gal/ton beets. BOD in effluent - 15.6 lb/ton beets. Future plans: Recycle of flume water. Improve ponds - 80% reduction in waste discharge expected.

WATER USE, RE-USE AND DISPOSAL

The Amalgamated Sugar Company at Nampa, Idaho

A. Beets sliced, tons/day:--4824; Non-Steffen; Gross raw water intake:--8640 (GPD x 10^3); Source; Nine wells - no treatment.

B. Flow sheet type II. Modifications: Flume and general wastes after screening to hydroseparator, then to City Sewage Plant. All fluid wastes to City Treatment Plant. No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	0			0	-	0
Condensers and Cooling	7776	0	6192		340(1)	-	
Diffuser Supply	0	1100(1)				-	
Lime Mud	0					-	
Steffen Dilution	-					-	
Miscellaneous	764					-	

(1) Estimated by editor

D. Waste Treatment

1. Flume and general waste screened, discharged to hydroseparator; mud to mud pond, 33.2 acres; clear liquor 240 x 10^3 GPD to Nampa City Treatment Plant. (BOD to City Plant 225 ppm, BOD from City Plant / to 20 ppm) City sewage plant discharge to Indian Creek.
2. Condenser water (7776 gal x 10^3 /day) discharged to flumes and miscellaneous.
3. Sanitary sewer to septic tank. Discharge is chlorinated; then to creek.
4. Lime mud to mud pond with flume mud. Overflow to city treatment plant.
5. Pulp and pulp press water 100% recycled.

Special: Plant will be doubled in slicing capacity for 1969-70--9600 tons. Will store part of thick juice for processing in intercampaign also planned. Recycle of overflow from mud pond to flumes.

Note: Nampa city charges for waste treatment based on volume, BOD and suspended solids content.

WATER USE, RE-USE AND DISPOSAL

The Amalgamated Sugar Company at Nyssa, Oregon

A. Beets sliced, tons/day:--6605; Molasses worked, tons/day:--204; Gross water intake:--14400 (GPD x 10^3); Source: River, no treatment.

B. Flow sheet type III. Modifications: No cooling and recycling of condenser water. Excess discharged to stream.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	8640					
Condensers	11520	0	1440		720		
Diffuser Supply	0	668					
Lime Mud	0						
Steffen Dilution	357						
Miscellaneous (includes gas washer)	2523						

D. Waste Treatment

1. Flume and general waste screened, discharged to two ponds, 45 A total x 10' deep, retention 7 hours, recycled. $Ca(OH)_2$ added after screening (1 ton CaO/1000 ton beets), pH about 11. Odor thus minimized.
2. Condenser water (excess) discharged to river @ 40° C. (about 7200 GPD). BOD 14 to 19 ppm.
3. Lime mud discharged to lime pond (one-27 A) - all effluent contained.
4. Steffen waste - 100% evaporated.
5. Pulp and pulp water returned to diffuser.
6. Floor drainage (432 x 10^3 GPD) to main sewer to river. Discharge to river (total) about 170 ppm BOD; pH 7.9 - 9.5. Flow of river - low, ca 4000 GPM.
7. Quentin (MgO) process ion exchange, some back wash to sewer.
8. Sanitary sewage to Nyssa City Sewage Plant.

Special: 6 to 10% increase in slicing planned. Increased waste sewer pump capacity 53,000 cu. yd. soil removed annually from ponds - cost about $0.50/cu. yd. Cost of waste treatment facilities $338,000, annual cost $40,000.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at Clarksburg, California

A. Beets sliced, tons/day:--3000; Non-Steffen; Gross water intake:--8000 (GPD x 10^3); Source: Wells - 576, River - 7424; Pre-treatment: 15% of water treated with chlorine and lime.

B. Flow sheet type III. Modifications: No Steffen. Condenser water is not cooled and recycled.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	3070	4320					
Condensers	4500	0	1080		X		21
Diffuser Supply	0	1000					
Lime Mud	0						
Other	430						

D. Waste Treatment

1. Flume and general wastes screened. Discharged to holding ponds, two, total 12 acres. Depth 4 ft. Retention 1.25 days. Discharged to river 8000 GPD x 10^3. BOD in waste discharged 6481 lb/day.
2. Condenser water (3400 x 10^3 GPD) discharged to river (Sacramento) @ 50° C.
3. Lime mud ponded - 3 ponds - 12 acres total. No overflow.
4. Gas washer water from well to river. Volume 58 x 10^3 GPD.
5. Sanitary sewer to septic tank, overflow chlorinated.

   Special: New ponds, new screens. Will screen and settle in ponds all flume water (6 acres). Recycle settled. Overflow 5700 GPM, spring 1970. Big problem - disposal of lime cake.
6. Pulp pumped ¼ mile to North American Dryer - Transport and pulp press water returned to diffuser.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at Rocky Ford, Colorado

A. Beets sliced, tons/day:--3024; Total Campaign:--435402: Molasses worked, tons/day:--94; Total campaign:--13509; Gross water intake:--8000 (GPD x 10^3); Source: Wells and artificial lake drawing water from Arkansas River - pre-treatment: Nalco #128, 3 ppm.

B. Flow sheet type II. Modifications: Many. Raw water, in part, to flumes, diffuser, lime mud. Lime pond - no overflow. Steffen waste to pond - no overflow.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	800	0					
Condensers and Cooling	5818	0	X		X		
Diffuser Supply	800	Yes					
Lime Mud	240						
Steffen	342						

D. Waste Water Treatment

1. Flume and general wastes not screened. Discharged direct - 8000 GPD x 10^3. BOD in waste - 6000 to 8000 lb/day.
2. Lime mud to one pond, 20 acres, no overflow.
3. Condenser water to flumes.
4. Pulp and pulp press water recycled to battery 100%.
5. Steffen waste to pond; disposed by evaporation (some seepage).
6. Sanitary sewage to city lagoons.

E. Comments: Cost of waste treatment facilities $200,000. No future increase in slicing anticipated. Estimated pounds BOD discharged to stream per ton beets not known. Volume waste discharged per ton beets sliced, ca 2330 gal.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at Chaska, Minnesota

A. Beets sliced, tons/day:--2000; Non-Steffen; Gross water intake:--4000 (GPD x 10^3); Source: Minnesota River and Springs: Pre-treatment: 100% with Nalco 918; Cost of treatment: $4500/ year.

B. Flow sheet type III. Modifications: No Steffen. Condenser water direct to river (no cooling).

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	3000					
Condensers and Cooling	3500				150		0
Diffuser Supply	0	325					
Lime Mud	36						
Other	464						

D. Waste Treatment

1. Flume and general wastes screened, then to one mud pond, 12 A, 8 to 10 ft. deep. Recycle (100%) back to factory water clarifier. Mud to mud pond. Lime added after screening.
2. Lime mud discharged to lime pond, 10 A. Overflow to general pond, 54 x 10^3 GPD.
3. Condenser water discharged direct to river, 3000 x 10^3 GPD. Temperature 25-40° C.
4. Gas washer from raw and clarified water. Discharged to clarifier, 75 x 10^3 GPD. Acid washes to lime pond. Sanitary sewer to city sewage treatment plant.
5. Pulp and pulp press water completely recycled - makeup with condenser water.

Special: Expect 10% increase in slicing. Will recycle condenser water; dewater sludge from clarifier. Estimated cost present waste treatment system $250,000; operating cost $12,000/year.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at Moorhead, Minnesota

A. Beets sliced, tons/day:--3585; Long campaign:--644,000 tons beets; Gross water intake:--4328 (GPD x 10^3); Source: River, pre-treated with Nalco #918.

B. Flow sheet type II. Modifications: No Steffen. Excess condenser water to ponds or river (no cooling). Wastes ponded and discharged according to river flow.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	1100					
Condensers and Cooling	4328		3265		650		196
Diffuser Supply	0	100%					
Lime Mud	0						

D. Waste Treatment

1. Flume and general waste not screened. Discharge to four ponds, total area 183 acres, depth 9 feet. Discharge to river depends on river flow. Discharge usually about 10^6 GPD (only half that in mid-July, 1969). Some odor problem during long storage. 941 gallons effluent discharged per ton beets, 3.5 lb. BOD in effluent per ton beets (16,412 lb. BOD per day equivalent to 4.6 lb/ton beets. About 1 lb. BOD/ton lost in storage).
2. Lime mud discharged to pond, 34 acres. No overflow. Waste held until beginning next campaign - discharged with general waste.
3. Pulp and pulp press water - 100% recycled to diffuser.
4. Condenser water (excess - 217 x 10^3 GPD) discharged direct to river @ 45° C.
5. Sanitary sewer to city sewer system.

E. 1300-1400 ton increased slicing during next ten years. Waste treatment will include aeration, closed loop, recycling, clarifying. With proposed changes, discharge of wastes to stream will be greatly reduced.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at Crookston, Minnesota

A. Beets sliced, tons/day:--3494; Total campaign:--646000; Gross water intake:--5800 (GPD x 10^3); Source: Red Lake River, no treatment.

B. Flow sheet type II. Modifications: No Steffen. Excess condenser water to river. Wastes ponded, controlled discharge after ice breaks up according to river flow.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	1100					
Condensers and Cooling	5800		5500		386		300
Diffuser Supply	0	386					
Lime Mud	0						

D. Waste Treatment

1. Flume and general waste screened, discharged to two ponds, total area 146 acres, depth 14 ft. Retention variable. Discharged to Red Lake River until river freezes - remainder after spring thaws. Controlled discharge to maintain dissolved oxygen down stream in river of 5 ppm and no deleterious effect on domestic water supplies. October 3-December 7, 1968, 362 x 10^6 gallons containing 500 ppm BOD discharged; April 18-June 6, 1969, discharges as follows:

	Total gal x 10^6	May GPD x 10^6	BOD
North Pond	291.4	15.0	850
South Pond	116.8	15.2	1580
Lime Pond	17.0	0.5	4400

2. Lime mud to two ponds, 12 acres.
3. Condenser water excess, 1500 GPD x 10^3 discharged to river @ 45° C.
4. Other wastes to general ponds.
5. Pulp and pulp press water 100% recycled to diffuser.

E. Special Information: No increase in slicing over 5000 tons/day expected. Planned: A clarifier, screens, recycle of beet flume water. Cost of present waste water facilities $500,000. Annual operating costs $25,000. Waste effluent to river - gal/ton beets 1220; BOD, lb/ton beets 8.8.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at East Grand Forks, Minnesota

A. Beets sliced, tons/day:--2750; Gross water intake:--5000 (GPD x 10^3); Source: Red River - all treated with 2 ppm phosphate - cost $2500/year.

B. Flow sheet type II. Modifications: No Steffen. Wastes ponded (no screening). Controlled discharge after ice breaks up, during floods.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	500						
Condensers and Cooling	4500		4000		400		12
Diffuser Supply	0	400					
Lime Mud	0						

D. Waste Treatment

1. Flume and general wastes not screened. Discharged to one pond, 155 acres in 11 bays. Retention time 11 days. Discharged to Red River of the North. Volume discharged (GPD x 10^3) 4500 average. BOD in waste discharged 8250 lb/day. Discharge regulated to avoid high BOD concentrations in river. Effluent at start about 1000 ppm BOD, in July, 1969, 640 ppm. Typical samples from river:

	DO - ppm	BOD - ppm
Above outfall	8.0	2.6
Below outfall	8.4	5.6
2¼ miles below	4.4	3.4
28 miles below	8.1	2.2

2. Lime mud discharged to three ponds, 5 acres. No overflow discharge. In spring about 2000 - 3000 lb/day BOD discharged.
3. Condenser water to flumes.
4. Sanitary sewer to City Sewage Plant.

E. Comments: Main pond contains floor drainage. Waste line runs two miles underground to river. Impossible to empty pond rapidly during river flood.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at Drayton, North Dakota

A. Beets sliced, tons/day:--3915; Total sliced, campaign:--688721; Gross water intake:--8794 (GPD x 10^3); Source: River - 2% of water from City of Drayton. Treated with 2 ppm PO_4.

B. Flow sheet type III. Modifications: No Steffen. Condenser water not cooled and recycled. Wastes ponded, controlled discharge to river during floods in spring.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	870					
Condenser and Cooling	8500		7800*		398		246
Diffuser Supply	0	370					
Lime Mud	0						
Other	294						

*Includes 1000 to beet washer and sprays.

D. Waste Treatment

1. Flume and general waste screened. Discharged to two ponds, 250 acres total, 16 ft. deep, 7 days retention until freeze-up, then until ice break-up in river (spring). Discharged to Red River, 5490 GPD x 10^3 in fall, 31,667 in spring-summer, regulated according to river conditions. Total wastes discharged to river 2000 gal/ton of beets, BOD in discharge 14/ton.
2. Lime mud to one pond, 60 acres, overflow discharged to general ponds.
3. Other wastes, floor drainage 5 x 10^3 GPD, BOD 210 lb/day (sugars 300 lb). Gas washer to main sewer.
4. Pulp and pulp press water 100% recycled.

E. Suspended solids 100% removed in lagoons, 10% of BOD reduced. No increase in plant capacity expected. No change in waste disposal planned. Sanitary sewage to Drayton city lagoon (estimated BOD 64 lb/day). No odor problem.

WATER USE, RE-USE AND DISPOSAL

American Crystal Sugar Company at Mason City, Iowa

A. Beets sliced, tons/day:--1881; Non-Steffen; Gross water intake:--7340 (GPD x 10^3); Source: Wells - 860, River - 6480 (Winnebago River).

B. Flow sheet type II. Modifications: No Steffen. Flume and general waste not screeeed, recycled back to flumes. Excess held 190 days, then discharged to river. No discharge from lime pond. Excess condenser discharged to river.

C. In-Plant Water Flows (GPD x 20^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	1720	7150					
Condensers and Cooling	5370				365		
Diffuser Supply		225					
Lime Mud	250						

D. Waste Treatment

1. Flumes and general waste not screened. $Ca(OH)_2$ added, discharged to three holding ponds - 85 acres total. Retention 3 to 282 days. Then discharged to river. Volume 1036 average (193 day period). BOD in waste discharged 8991 lb/day. Some odor problem.
2. Lime mud ponded, one pond - 38 acres, overflow not discharged. Volume 98 x 10^3 GPD. BOD in waste to pond 3680 lb/day.
3. Condenser water. Excess discharged to river @ 33° C. average, 5000 x 10^3 GPD. BOD 61 ppm average.
4. Pulp and pulp press water recycled to diffuser.
5. 638 gallons ponded water plus 2658 gallons condenser water per ton of beets, discharged to stream. About 6.89 lbs BOD to stream per ton of beets sliced.

Special: Future increase in slicing, ca 10%. Expect to effect closed loop waste treatment. Waste discharged to river, regulated over period of about ten months to insure positive oxygen balance.

WATER USE, RE-USE AND DISPOSAL
Buckeye Sugars, Inc. at Ottawa, Ohio

A. Beets sliced, tons/day:--1600-1700; Total campaign:--220,000; Gross water intake:--2,000 (GPD x 10^3 ,; Source: Blanchard River (settling pond to remove settleable solids).

B. Flow sheet type III. Modifications: No Steffen. Mechanical clarifier for flume water, thence to ponds - 120 days retention. Controlled discharge.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	1440					
Condensers and Cooling	2000	3560	460	3560	72		
Diffuser Supply	0	100%					
Lime Mud	0						

D. Waste Treatment
1. Flume and general waste screened, lime added (pH 9) to clarifier, mud to ponds, sedimentation pond, 3 acres, to main holding pond, 8 acres, 12 ft. banks, to recycle. Then to Blanchard River; 120 day retention in ponds.
2. Lime mud to two ponds, 5 acres, 5 ft. deep, overflow to 8 acre holding pond. Two 7½ HP aerators in holding pond to control odor and reduce BOD.
3. Pulp and pulp press water recycled to diffuser - 100%.
4. 110 gal waste discharged/ton beets and 0.14 lb BOD/ton beets.
5. Condenser water recycled through spray pond, 6 acres.
6. Sanitary sewer to city sewage plant.
7. Gas washer, source, condensers, discharged to flumes.
8. Floor drains to main sewer to holding pond.

E. Comments: Sodium nitrate and copper sulfate added to settling pond. 23 x 10^6 gal waste accumulates during campaign - controlled discharge afterward. No increase in slicing contemplated. Future plans: all waste waters, after screening and settling, will go to new city sewage treatment plant when completed in 1970 or 1971. Cost of cleaning lagoons $1.00 per cu. yd., $20,000 annually. City will charge $12,000 annually. Estimated future cost of waste disposal $0.16/ton beets.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Loveland, Colorado

A. Beets sliced, tons/day:--3688; Total campaign:--399000; Molasses worked, tons/day:--190; Total campaign:--20300; Gross water intake:--13070 (GPD x 10^3); Source: Lake Loveland (from Big Thompson River) - 13,000; from city - 70. City water filtered and chlorinated.

B. Flow sheet type II. Modifications: Condenser water to flumes, excess to streams. All other water usage from raw water. Steffen waste evaporated.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	0					
Condensers and Cooling	11000		9670				
Diffuser Supply	670	670			670		
Lime Mud	710						
Steffen Dilution	432	45%					
Miscellaneous	258						

D. Waste Treatment
   1. Flume and general waste not screened. Discharged to three ponds, total 119 acres, 1 ft. deep. Retention 4 days. Discharged to Big Thompson River - 9670 GPD x 10^3. At times overflow from Boyd Lake runs through ponds, up to 5000 GPD x 10^3. When this happens, DO in effluent rises to 7 ppm.
   2. Lime mud 500 GPD x 10.3 runs into flume water ponds.
   3. Condenser water: 928 GPD x 10^3 direct to Boyd Lake; remainder to flumes.
   4. Steffen waste evaporated.
   5. Other factory wastes to main ponds. Total volume - 135 x 10^3 GPD.
   6. Pulp and pulp press water recycled.

E. Comments: No planned increase in slicing. Will install 100% flume water recirculation and separate lime pond. Cost of waste water system $1,000,000. Annual cost $50,000.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Greeley, Colorado

A. Beets sliced, tons/day:--2145; Total campaign:--219000; Gross water intake:--6050* (GPD x 10^3); Source: Wells - 806, Cache la Poudre - 4315, City storm sewer - 1939; 11% filtered and chlorinated.

B. Flow sheet type II. Modifications: No Steffen. Raw water to lime mud to lime pond. No general ponds - all discharge to long winding ditch - 5900 ft. to stream.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	2560					
Condensers and Cooling	5121		1800		258		
Diffuser Supply	0	258					
Lime Mud	202						

D. Waste Treatment

1. Flume and general waste screened, discharged through a winding ditch - 15 ft. wide by 6 ft. deep, 5900 ft. long to Poudre River. Area of ditch 3.7 acres. Retention time 5½ hours. Volume 6050 GPD x 10^3. BOD in discharge, 3 lb/ton beets.
2. Lime mud to pond, 4.6 acres. No overflow - seeps away.
3. Condenser water excess discharged to ditch with flume water to Poudre River. Volume 3700.
4. All other factory wastes to main sewer to flume water ditch. Volume 200.
5. Sanitary sewer to city sewage treatment.
6. Pulp and pulp press water 100% recycled to diffuser.
7. Effluent discharged 2400 gal/ton beets. BOD in effluent, 3.12 lb/ton beets.

E. Comments: No increase in slicing planned. Holding ponds and total recycling of flume water planned. Also, cooling and recirculation of condenser water. Will need additional water. BOD will be reduced to 0.4 lb/ton. Cost of present waste treatment $182,000. Annual operating cost $10,000.

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Eaton. Colorado

A. Beets sliced, tons/day:--2000; Total campaign:--217140; Gross water intake:--3268 (GPD x 10^3); Source: Wells - 3100, City - 140. Pre-treatment: main water Nalco #128, cost $2400/year.

B. Flow sheet type II. Modifications: No Steffen. Raw water to lime mud - lime pond.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	5050					
Condensers and Cooling	3116	3116			288		
Diffuser Supply	0	280					
Lime Mud	152						

D. Waste Treatment

1. Flume and general waste screened and pumped to two mud ponds, 0.35 acres each, used alternately (10 ft. deep), one settling surge pond (0.4 acres x 4 ft. deep). Ion exchange regenerants to chemical pond (1.3 acres) - no discharge. Seepage, zero BOD to stream.
2. Condenser water to spray pond. Two wells (1500 GPM each) pumped to cool water. Overflows to 6 mile ditch to Poudre River.
3. Lime mud ponded. One pond, ca 6 acres. Overflow to seep ditch. No discharge to river.
4. Sanitary sewage to city sewer system.
5. Other wastes: gas washer water, source wells - discharged to seep ditch.

E. Comments: Milk of lime added to flume water after screening pulp and pulp press water recycled to diffuser. No increase in slicing anticipated. No change in waste treatment. Cost of waste treatment facility $160,000. Operating cost $26,000 per year. Effluent to stream per ton beets - 760 gal.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Longmont, Colorado

A. Beets sliced, tons/day:--3307; Total campaign:--378000; Molasses worked, tons/day:--189; Total campaign:--21620; Gross water intake:--11000* (GPD x 10^3); Source: St. Vrain River - 10,000, City - 970; City water filtered and chlorinated.

B. Flow sheet type III. Modifications: Raw water to diffuser make-up and to lime mud - to lime pond. No discharge - seepage. Condenser water direct to streams.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	3597	(4660)				
Condensers and Cooling	9000						
Diffuser Supply	432	432					
Lime Mud	216						
Steffen Dilution	432						

D. Waste Treatment
   1. Flume and general waste screened; 3600 recycled direct to flumes; 4660 limed, thence to mud lagoon (a) or (b) 0.276 acres, 10 ft. deep to (b) surge pond 1.79 acres, thence to flumes, or excess to (c) anaerobic pond 1.61 acres, 15 ft. deep. Latter held until BOD is reduced to 100 ppm before discharge. Normally no discharge to stream. Some odor in (c); corrected by two 25 HP aerators. Pond, therefore, not altogether anaerobic.
   2. Condenser water direct to stream.
   3. Lime mud to pond, 22 acres, supernatant evaporates or seeps - no discharge.
   4. Steffen waste evaporated.
   5. Sanitary sewage to septic tank and leach field.
   6. Gas washer water, source, raw water discharged to intake pond.

E. Comment: Cost of waste facilities \$260,000. Annual operating cost \$40,000; 890 gal (condenser water only) discharged per ton beets, BOD to stream 0.35 lb/ton of beets.

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Sterling, Colorado

A. Beets sliced, tons/day:--2435; Total campaign:--290000; Gross water intake:--6100 (GPD x 10^3); Source: River - 5100, City - 1000, Wells (in emergency, as river frozen). Pre-treatment Nalco 918. Cost $1500/year.

B. Flow sheet type II. Modifications: No Steffen. Flume water and general wastes direct to stream (no ponds). Lime mud to ponds - no overflow. Condenser water excess direct to river.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flume	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flume	1525	1403					
Condensers and Cooling	4179	0	4179	-	-		-
Diffuser Supply	151	454					
Lime Mud	62						
Miscellaneous	183						

D. Waste Treatment

1. Flumes and general waste not screened. Discharged direct to South Platte River through 3/4 mile ditch - 5612 GPD x 10^3, containing 13,500 lb BOD per day.
2. Lime mud to pond, 4.4 acres. Overflow is not discharged but pond close to river; perhaps seepage.
3. Condenser water discharged direct to river, 4117 GPD x 10^3 @ 45° C.
4. Other wastes - 70,000 gal/day. BOD not known, discharged to river.
5. Sanitary sewer to Sterling Sewage Treatment System.
6. Pulp press water 100% recycled.
7. Present operating costs of waste water handling about $1500 per year.

E. Comments: No increase in slicing anticipated. Planned (1970-71) changes in waste treatment: flume water recirculation system with ponds - $250,000; annual operating costs $25,000. Estimated volume effluent per ton of beets 2415; BOD 5.6 lb/ton beets.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Brighton, Colorado

A. Beets sliced, tons/day:--2178; Total campaign:--278000; Gross water intake:--4070 (GPD x 10^3); Source: Wells - 864, River - 3136, City - 70. Water intake screened, treated with Nalco. Cost $4000/year.

B. Flow sheet type III. Modifications: Raw water to lime mud - to lime pond. No discharge. Excess condenser water - very little - direct to ditch, to river. Practically no BOD to stream.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	5750					
Condenser and Cooling	3872	3740			305		
Diffuser Supply		360					
Lime Mud	198						

D. Waste Treatment

1. Flume and general waste screened; to mud pond (a) 0.253 acres, to (b) suge pond 1.77 acres, recycled to flumes or to (c) when build-up occurs, 17.1 acres. No discharge from (c) - seeps or evaporates.
2. Condenser water to spray pond, recirculates to condensers. Additional water added to lower temperature - overflow to ditch and South Platte River. New plans include more sprays to lower temperature.
3. Lime mud to lime pond, 4 acres, overflow seeps away or evaporates. No BOD discharged.
4. Sanitary sewage to city sewage system.
5. Milk of lime added to flume water after processing.
6. Pulp and pulp press water recycled to diffuser.

E. Comments: Cost of facility $300,000. Annual operating cost $54,000.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Fort Morgan, Colorado

A. Beets sliced, tons/day:--3632; Total campaign:--453433; Molasses worked, tons/day:--187; Total campaign:--23390; Gross water intake:--12000* (GPD x 10^3); Source: South Platte River.

B. Flow sheet type II. Modifications: Raw water to flumes to diffuser make-up and lime mud. Flume and general wastes not screened - to ponds - to river. 85% Steffen waste evaporated.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	7990	0					
Condensers and Cooling	2203	0					
Diffuser Supply	194	483					
Lime Mud	272	0					
Steffen Dilution	249	0					

D. Waste Treatment

1. Flume and general waste not screened. Discharged to two ponds, 2½ acres each, 3 ft. deep, retention 3 hours. Thence to river. Volume 12,000 GPD x 10^3, 20,000 lb. BOD per day.
2. Lime mud to one pond, 10 acres, overflow to river - 272 GPD x 10^3. BOD included in general waste.
3. Condenser water discharged direct. Volume 4000 GPD x 10^3, temperature 30° C.
4. Steffen waste evaporated - 85% of total. Remainder to main sewer.
5. Other wastes - floor drainage, gas washer water, chemical washes discharged to main sewer.
6. Sanitary sewer to city sewer plant.
7. Pulp and pulp press water 100% recycled.

E. Comments: Slicing to be increased 2400 tons between 1969 and 1979. Waste treatment to include flume water recirculation. Cost $250,000. Operating cost $25,000 per year (estimated). Cost of present facilities $150,000, $3500 per year. Effluent discharge 2200 gal per ton beets, containing 5 lb BOD per ton beets.

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Billings, Montana

A. Beets sliced, tons/day:--4250; Total campaign:--595000; Molasses worked, tons/day:--180; Total campaign:--25200; Gross water intake:--18000* (GPD x 10^3); Source: Yellowstone River.

B. Flow sheet type II. Modifications: Raw water for all purposes, except 1250 x 10.3 GPD condenser water reused in flumes. Steffen waste to lime pond until 1968-69; evaporated in 1969-70.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	10000	0					
Condensers and Cooling	3000	0	1250				0
Diffuser Supply	170	756					
Lime Mud	110						
Steffen Dilution	128						

D. Waste Treatment

1. Flume and general waste screened: 2000 discharged to pond (in 1968) - 3 basins, 1/3 acre each; two used at same time. Then to long channel - 6 passes, 1000 ft. each by 35 ft. wide. New, one additional pond 1400 ft. long x 60 ft. wide. Discharges to Yeager ditch and to river. Cost cleaning channels and ponds during and after campaign about $13,000. BOD entering system 770 ppm, leaving about 700 ppm (no change). Later (December) BOD 300 ppm. Settleable solids reduced from 4000, average to 125 ppm. Volume effluent 8-10 million gal/day from ponds - some bypassed. Total perhaps 11 million.
2. Lime mud to one pond, 40 acres. No overflow.
3. Condenser water - 1420 GPD x 10^3 discharged to river at 55° C.
4. Steffen waste evaporated in 1969 - previously to lime pond.
5. Other wastes to sewer.
6. Sanitary sewer to city plant.

E. Comment: Volume effluent about 2600 gal per ton beets - about 7 lb. BOD per ton beets.

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*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL
The Great Western Sugar Company at Lovell, Wyoming

A . Beets sliced, tons/day:--2183; Total campaign:--310000; Gross water intake:--5000* (GPD x 10^3); Source: Shoshone River.

B. Flow sheet type II. Modifications: No Steffen. Raw water to flumes. Flume water screened, then to river, no general settling ponds. Lime mud to ponds - no discharge.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	2248						
Condensers and Cooling	1552		1312		240		0
Diffuser Supply	0	432					
Lime Mud	200						

D. Waste Treatment

1. Flumes and general waste screened (1969) - 3 vibrating screens, then direct to river--4424, no ponds.
2. Lime mud to pond, 29 acres. No overflow - evaporation and seepage.
3. Condenser water discharged direct to river - 1312.
4. Other wastes: gas washer water 100; floor drainage 72; boil outs - all to sewer and river.
5. Sanitary sewage to city plant.

E. Comments: Cost of present waste treatment facilities $57,000; operating costs not available (but considerable). Effluent to stream 2010 gal per ton beets. BOD to streams not available (author's estimate 8-10 lbs per ton beets). No increase in slicing planned.

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company, Scottsbluff, Nebraska

A. Beets sliced, tons/day:--3366; Total campaign:--336860; Molasses worked, tons/day:--175; Total campaign:--16600; Gross water intake:--12000* (GPD x 10^3); Source: Wells - 2400, Winter Creek - 9600. Pre-treatment: Nalco #519 to 70% of flow.

B. Flow sheet type II. Modifications: In 1968-69, pulp to silo, in 1969-70 to dryer (II). Flume and general wastes not screened but to ponds, then river. Steffen waste evaporated.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	2500	0					
Condensers and Cooling	7750	0	7500		1023		
Diffuser Supply		1203					
Lime Mud	5						
Steffen Dilution	240						

D. Waste Treatment

1. Flumes and general wastes not screened, to ponds, three in use each year, 100 acres, 6 ft. deep, thence to North Platte River. Volume (Nebraska State measurements) 4450; 23,500 lb BOD, per day.
2. Lime mud to ponds, overflow to general ponds. Volume 4.5 GPD x 10^3. BOD unknown.
3. Condenser water - 1572 discharged to general ponds, remainder (except 1023) to flumes, thence to ponds and river.
4. Steffen waste - 100% evaporated.
5. Other wastes, including sanitary sewer, to general ponds.
6. Pulp and pulp press water recycled to diffuser. Pulp dryer installed in summer 1969; hence no pulp silo drainage in 1969-70 campaign.

E. Comments: Flow figures not consistent. Their estimate of effluent per ton beets sliced 1367 gal; 7 lb BOD per ton sliced. Probably considerable seepage to river. Proposed changes expected to reduce BOD to 2 lb/ton.

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Gering, Nebraska

A. Beets sliced, tons/day:--2250; Total campaign:--240000; Molasses worked, tons/day:--100; Total campaign:--12000; Gross water intake:--5000 (GPD x 10^3); Source: Winter Creek.

B. Flow sheet type II. Modifications: Raw water to flumes. Lime pond has no discharge. Steffen waste evaporated. Condenser water to flumes - no recycle.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	2500						
Condensers and Cooling	2476		2476		0.5		
Diffuser Supply	-	22					
Lime Mud	1						
Steffen Dilution	13						

D. Waste Treatment

1. Flume and general wastes screened and discharged to two ponds, 3 acres each. Retention time 2 hours. Discharged, 5000, to North Platte River. BOD in effluent 12,000 lb/day.
2. Lime mud discharged to pond, 5 acres. No overflow - seeps.
3. Condenser water discharged direct - 2476 @ 35° C.
4. Steffen waste 100% evaporated.
5. Other wastes all to main sewer, i.e., to general wastes.
6. Pulp and pulp press water all recycled to diffuser.

E. Comments: No increase in slicing planned. Flume water settling basin constructed in 1969 to remove settleable solids. Estimated cost of treatment facilities \$52,000; annual costs \$5,000. Effluent discharged per ton beets 2220 gal. BOD 5.0 lb/ton beets. No flume water recirculation planned. Note: Check made 10-29-69--BOD per day 11,000, suspended solids in effluent 830 ppm.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Bayard, Nebraska

A. Beets sliced, tons/day:--2174; Total campaign:--216037; Gross water intake:--8290* (GPD x 10^3); Source: River - pre-treatment to 90%. Nalco #918. Cost $1800 per year.

B. Flow sheet type II. Modifications: No Steffen. Flume and general waste not screened, run to four general ponds, thence to river. Lime mud to general ponds.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0						
Condensers and Cooling	6500		6000		233		
Diffuser Supply	0	285					
Lime Mud	3						

D. Waste Treatment

1. Flume and general waste not screened. To ponds (four), total 120 acres, 4 ft. deep. Discharged to North Platte River. Volume effluent 6300, BOD 1100 lb/day (State of Nebraska measurement).
2. Lime mud to general ponds (four), 120 acres. Volume 13 GPD x 10^3.
3. Condenser water excess above in-plant re-use about 1200 to general ponds, temperature 55° C.
4. Other wastes all, including sanitary sewer, to main ponds, 120 acres.
5. Pulp and pulp press water recycled to diffuser.

E. Comments: This factory and a few others of Great Western Sugar Company drip Nalco 674 into wastes-- 1¼ lb per day--to mask odors. Forty-day increase in campaign for 1969-70 campaign. No changes in waste treatment planned. Cost of waste treatment facilities $37,000. Operating costs $4350 per year. Volume effluent 2890 gal per ton beets. BOD estimated 5 lb per ton beets.

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*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Mitchell, Nebraska

A. Beets sliced, tons/day:--2184; Total campaign:--229274; Gross water intake:--8500* (GPD x 103); Source: Wells - 1500, Spotted Yellowtail Creek - 7000. Pre-treatment 85% with Nalco 918. Cost $1100/year.

B. Flow sheet type II. Modifications: No Steffen. Flume and general wastes not screened, run to ponds, thence to river. Lime mud to flume ponds.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0						
Condensers and Cooling	6500	0	4250		0		
Diffuser Supply		2400					
Lime Mud	215						

D. Waste Treatment

1. Flumes and general wastes not screened. To ponds, one with five sections, 88 acres, total. Depth 6 ft. Days retention - 80. Discharged to North Platte River 1050 (State of Nebraska measurement, 14,077 lb BOD per day). Pond adjacent river. Probable seepage.
2. Lime mud combined with flume water in 88 acre pond.
3. Condenser water - 2000 discharged direct, 4250 as flume water, all to pond. Temperature 55° C.
4. Other wastes, including sanitary sewer, approximately 151 GPD x 10^3 to pond.
5. Pulp and pulp press water 100% recycled.

E. Comments: Ten percent increased annual slice planned. Cost of present waste disposal facilities $30,000. Annual operating cost $3300. Estimated BOD discharged per ton of beets 4.3 lbs. Volume effluent 500 gal. per ton beets (appears low).

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*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Ovid, Colorado

A. Beets sliced, tons/day:--2617; Total campaign:--290000; Gross water intake:--11692* (GPD x 10^3); Source: Wells 100% (river - standby).

B. Flow sheet type II. Modifications: Raw water to flumes, condensers, diffuser supply, lime mud. Flume and general waste screened - no ponds, thence to river. No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycle	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	4864						
Condensers and Cooling	5820	0	3900				
Diffuser Supply	812	360					
Lime Mud	58						

D. Waste Treatment
1. Flume and general waste screened, discharged direct to river (no ponds), 10,350, BOD unknown
2. Lime mud to pond - 1. Overflow discharged to river - 28.
3. Condenser water - 5820 discharged direct to river @ 45° C.
4. Sanitary sewer to city sewer system.
5. Pulp and pulp press water 100% recycled to diffuser.
6. Other wastes - to general waste.

E. Comments: No increase in slicing planned. Flume water recirculation system will be installed. Cost $250,000. Annual operating cost $25,000 estimated. Cost of present waste facilities $100,000. Annual operating cost $3,000. Effluent discharged 3450 gal. per ton beets sliced. BOD in effluent 5 lb/ton beets (estimated).

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

The Great Western Sugar Company at Goodland, Kansas

A. Beets sliced, tons/day:--2609; Total campaign:--355800; Gross water intake:--853 (GPD x 10^3); Source: 3 wells. Water treated with Nalco 918 - 50 lb/day. Cost of treating facilities $2500. Operating costs $600 per year.

B. Flow sheet type III. Modification: No Steffen. Discharges from pond, including lime pond, recycled or excess to anaerobic pond. No discharge to streams.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	11645					
Condensers and Cooling	811	7900	155		267		144
Diffuser Supply	0	255					
Lime Mud	0						
Miscellaneous	42						

D. Waste Treatment

1. Flume and general waste screened, to ponds "A" or "B", each 0.6 acres, to "C", 1.0 acre; 2100 recycled from screen to flumes; 9545 recycled from ponds to flume; 11 discharged by evaporation and seepage; 144 excess to anaerobic pond "E", 2.48 acres, no discharge to stream.
2. Lime mud all to lime pond "E", 12.1 acres. Water from lime mud to evaporation and seepage. No discharge to streams.
3. Condenser water to spray pond, 0.65 acres, cooled and recycled, from 70° to 25° C.
4. Floor drainage to main sewer to ponds, 217 GPD x 10^3 - 2430 ppm BOD, 3090 ppm sugar (high).
5. Gas washer to flume ponds - 12.
6. Sanitary sewer to stabilization pond, 2.48 acres.
7. Pulp press water 100% recycled; make-up water (diffuser) 217 - new water.

E. Comments: Plant capacity will be increased 1000 tons beets per day. No change in waste treatment. Cost of waste facilities $448,000. Annual operating cost $21,000.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Hamilton City, California

A. Beets sliced, tons/day:--1875; Total campaign:--270000; Ion-Exchange Treatment of 75% of machine syrup (High Green); Gross water intake:--4773 (GPD x 10^3); Source: Wells.

B. Flow sheet type III. Modifications: Ion-exchange treatment of high green. Raw water make-up to diffuser. No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Lime Mud	Ion-Exchange
Flumes	1980						
Condensers and Cooling	587	3160	1884		138	0	
Diffuser Supply	138	163					
Lime Mud						75	
Ion-Exchange	2068						

D. Waste Treatment

1. Flumes and general wastes screened, to one pond, 55 acres, 15 ft. deep, 20 days retention. No discharge.
2. Lime mud to one pond, size ?. Overflow - 10 - to general pond.
3. Condenser water to tower cooler and recycled.
4. Pulp and pulp press water 100% recycled to diffuser.
5. Ion-Exchange regenerants in part evaporated for fertilizer. First strip to pulp dryer, dilute wash to pond (main). (Owing to plant difficulty, some waste (acid) presently going to lime flume). Some complaints about odor.

E. Comments: No effluent discharged to streams. Expect to increase annual slicing to about 370,000 tons in next few years. No change in waste treatment planned.

WATER USE, RE-USE AND DISPOSAL
Holly Sugar Corporation at Santa Ana, California

A. Beets sliced, tons/day:--1851; Total campaign:--405088; Molasses worked, tons/day:--96; Total campaign:--21126; Gross water intake:--2270 (GPD x 10^3); Source: Wells.

B. Flow sheet type III. Modifications: Raw water transport of lime mud. Waste discharge to District Sanitary Plant. Steffen waste to ponds.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	-	Yes					
Condensers and Cooling	X		X		X		
Diffuser Supply	-	X					
Lime Mud	X						
Steffen Dilution	X						

D. Waste Treatment
1. Flumes and general waste screened, to three ponds, seven days retention, to Orange County Sanitation District, two million gallons per day.
2. Lime mud to ponds (two), overflow to general ponds.
3. Condenser water to tower cooler, recycled (in part), cooled to 32° C.
4. Steffen waste to ponds (not evaporated).
5. Other wastes to sewer, to ponds.
6. Sanitary sewer to sanitary district plant.
7. Pulp press water 100% recycled to diffuser.

E. Comments: Effluent discharged to streams - zero per ton of beets; BOD zero. All plant effluent is screened, passed through a flocculator, a clarifier, cooled by aeration, discharged to district sanitation district - 2 million gallons per day.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Worland, Wyoming

A. Beets sliced, tons/day:--1600; Total campaign:--214667; Molasses worked, tons/day:--76; Total campaign:--10177; Gross water intake:--7500 (GPD x 10^3); Source: Bighorn River.

B. Flow sheet type II. Modifications: Pulp drier with 100% recycle of pulp press water. Steffen waste to lime pond. Condenser water only to river. All other wastes ponded. No discharge. Ponds dry in intercampaign.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	4000						
Condensers and Cooling	2000	0	0		0	0	0
Diffuser Supply	500	250					
Lime Mud	100						
Steffen Dilution	100						
Miscellaneous	800						

D. Waste Treatment

1. Flume and general wastes screened, to ponds, 5, average 180. Retention 160 days. Ultimately dries up. No discharge to river.
2. Lime mud to ponds - 6 units, no discard.
3. Condensed waters discharged direct to Bighorn River.
4. Steffen waste to lime ponds. No discharge.
5. Pulp and pulp press water recycled.

E. Comments: Increase of 20% in slicing anticipated. Effluent discharged per ton beets - 0.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Sidney, Montana

A. Beets sliced, tons/day:--2500; Total campaign:--400000; Gross water intake:--6867 (GPD x 10^3); Source: Yellowstone River via ditch to pond to factory.

B. Flow sheet type II. Modifications: No Steffen. Overflow from lime pond to general (flume water) ponds, thence to stream.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0						
Condensers and Cooling	6867		6627		240		0
Diffuser Supply	0	480					
Lime Mud	0						

D. Waste Treatment

1. Flumes and general wastes screened, discharged to two ponds, 8.3 acres, 7 ft. deep. Retention 1.5 days. Discharged via canal to river - 6627 GPD x 10^3, 18,300 lbs BOD/day.
2. Lime mud to ponds (one in use), 712,000 cu. ft. Overflow - 95 GPD x 10^3 to general ponds.
3. No condenser water - discharged direct.
4. Other wastes: floor drainage - 10, containing 8,000 lbs "sugar" per day; gas washer water - 8; and chemical washes to lagoons. Sanitary sewer - 4.5 - to Sidney sanitation system.
5. Pulp press water 100% recycled.

E. Comments: Cost of present waste facilities \$67,000. Annual cost \$3,500. Beet slicing will ultimately be increased 1700 tons per day. Waste treatment will also include more complete re-use of waste water in closed system. Effluent discharged to stream: 2758 gal/ton beets; BOD - 7.8 lbs/ton.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Torrington, Wyoming

A. Beets sliced, tons/day:--3034; Total campaign:--330180; Molasses worked, tons/day:--139; Total campaign:--15121; Gross water intake:--7630* (GPD x 10^3 ; Source: North Platte River, some wells. Pre-treatment with Nalco balls. Cost $3700 per year.

B. Flow sheet type I. Modifications: Lime mud to lime pond, little overflow to river. Steffen filtrate 20% evaporated, remainder to lime pond. Waste is screened before discharge to river. Pulp water to separate lagoon, then to river.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	2290	-					
Condensers and Cooling	3816	-	2930		887		0
Diffuser Supply		-					
Lime Mud	190	-					
Steffen Dilution	19						

D. Waste Treatment

1. Flume and general waste screened (40 mesh), then to North Platte River. No recycle of flume water.
2. Lime mud to three ponds, 12 acres, no overflow, loss by seepage and evaporation.
3. Pulp silo drainage (no dryer) to lagoon, 50 acres, 1365 GPD x 10^3.
4. Steffen waste to lime ponds, 80%, evaporation, 20%.
5. Condenser water - 1527 discharged direct @ 41° C.
6. Other waste: floor drains - 200, 15,000 lb BOD per day; gas washer - 300; chemical washes including pans and evaporation - 16,700 lb BOD per day. All to main sewer and river.
7. Sanitary sewer to septic tank. Effluent to lime ponds.

E. Comments: Effluent (1483 gallons) discharged per ton beets. BOD in effluent 4-10 lb per ton beets.

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Hardin, Montana

A. Beets sliced, tons/day:--1700; Total campaign:--275000; Gross water intake:--4000 (GPD x 10^3); Source: Bighorn River, settled briefly, only. Cost $20,000 for reservoir and pumps, $10,000 annually for maintenance.

B. Flow sheet type III. Modifications: No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	0-25%					
Condensers and Cooling	4000	1000	3500		220		100
Diffuser Supply	0	300					
Lime Mud	0						

D. Waste Treatment

1. Flumes and general waste screened, all to four ponds, depth 7 ft., 2 days retention. Discharged - 3000 - to river, containing 45,000 lb BOD per day.
2. Lime mud to one pond, 6 acres. No overflow. Ponds empty after campaign by seepage and evaporation.
3. Condenser water to spray pond - 1000. None discharged to stream direct.
4. Other wastes: floor and miscellaneous drainage - 300 - to general ponds, containing 800-1000 lb sugar per day; gas washer (raw water - 150) to ponds; chemical wastes (little) to ponds. Little BOD.
5. Sanitary sewage to lime ponds.
6. Pulp and pulp press water 100% recycled.

E. Comments: Plan to increase slicing to 3000 tons per day. Will construct more settling lagoons for flume water and recirculate back to flumes. Cost of waste facilities (present) $10,000. Annual cost, including removing mud from lagoons, $5,000. Effluent discharged per ton beets sliced - 1800 gal; 26 lb BOD per ton beets. Proposed changes will reduce BOD to 3 lb/ton beets.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Delta, Colorado

A. Beets sliced, tons/day:--1500; Total campaign:--215000; Molasses worked, tons/day:--50; Total campaign:--6000; Gross water intake:--6000* (GPD x 10^3); Source: Gunnison River, principally. City water, some.

B. Flow sheet type III. Modifications: Condenser waters to flumes. No flume recycle. Raw water to diffuser.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0						
Condensers and Cooling	3000	0	3000				1
Diffuser Supply	360	360					
Lime Mud	1						
Steffen Dilution	120						

D. Waste Treatment

1. Flume and general waste screened, discharged to two ponds, 7 acres, 4 ft. deep.
2. Lime mud to ponds (one) - overflow to stream.
3. Condenser water discharged direct.
4. Steffen waste evaporated.
5. Other wastes: floor drains - 10,000 gal/day to ponds. Chemical wastes to ponds. Sanitary sewage to city plant.
6. Pulp and pulp press water recycled.

E. Comments: Slicing will be increased 400 ton/day. Flocculator, clarifier and new lagoon will be installed. Cost of system $63,000. Annual operating cost $13,000.

*Does not equal tabulated raw water use due to other non-process uses of water.

WATER USE, RE-USE AND DISPOSAL
Holly Sugar Corporation at Tracy, California

A. Beets sliced, tons/day:--2600; Total annually:--600000; Molasses worked, tons/day:--123; Total annually:--27919; Gross water intake: (GPD x 10^3) From canal - 2500 (c), From wells - 1000 (w).

B. Flow sheet type III. Modifications: Raw water make-up for diffuser. Raw water to flumes with no recirculation. Raw water to lime mud.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use			Water Re-Use					
			Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	(c)	2500						
Condensers and Cooling		X	5500	some				
Diffuser Supply	(w)	250	450					
Lime Mud	(w)	150						
Steffen Dilution	(w)	600						

D. Waste Treatment

1. Flumes and general wastes not screened - 2750 to six ponds, 30 acres, 4 ft. deep. (Actually used 4 passes only - short retention time). Discharged to "old" river (0.0 ppm DO, 450 ppm BOD).
2. Lime mud to pond, about 2 acres. Overflow - 150 - to general ponds.
3. Condenser water cooled in tower, recycled in part.
4. Steffen waste evaporated nearly 100%.
5. Other wastes: gas washer (from cooling tower) to flumes, 200. Sanitary sewer to septic tank. All other to general waste.
6. Pulp water 90% recycled to diffuser, 10% to general waste.

E. Comments: Slicing will be increased to 4000 tons/day; 90 ft. diam. clarifier to handle 7400 GPM flume water and new 10-mesh vibrating screen--all in next year or two. Effluent now discharged to stream: 1260 gal/ton beets. BOD in effluent to stream: 4-5 lb/ton beets.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Brawley (Carlton), California

A. Beets sliced, tons/day:--6500; Total campaign:--650000; Gross water intake:--3900 (GPD x 10^3); Source: All American Canal (Colorado River).

B. Flow sheet type III. Modifications: No return of pulp water to diffuser. No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	9700					
Condensers and Cooling	2800	5250	400		590		250
Diffuser Supply	860						
Lime Mud	240						

D. Waste Treatment

1. Flumes and general waste screened, to four ponds, 1040 acres, 4.5 ft. deep, 75 days retention. Discharge (2220) to drain canal, to Alamo River, to Salton Sea. Carries 3520 lbs BOD per day to stream.
2. Lime mud to six ponds, 16 acres. Overflow to general pond (see 1 above). BOD in lime pond overflow - 4000 lbs/day.
3. Condenser water to spray tower, (5250) cooled, recycled, 64° C. Other wastes to main sewer. Gas washer 1800 (raw water) discharged to flume ponds.
4. Sanitary sewer to septic tank. Effluent to general pond.
5. Pulp and pulp press water to main sewer, to general ponds.

Note: Flume water, after screening, sent to mechanical clarifier, then to ponds.

E. Comments: Planned soon to recycle water from settling pond to beet washer and flumes. Cost of present waste treatment facilities $250,000. Operating costs $1,000 per year. Effluent discharged to stream - 373 gal/ton beets; BOD 0.6 lbs/ton beets, (their estimates). Low figures due to large pond and long retention at high, average temperature--80-90° F.

WATER USE, RE-USE AND DISPOSAL

Holly Sugar Corporation at Hereford, Texas

A. Beets sliced, tons/day:--6493; Total campaign:--899000; Gross water intake:--1400* (GPD x 10^3); Source: Wells, some raw water treated - ion-exchange and softener.

B. Flow sheet type III. Modifications: Raw water (some) to condensers and to diffuser. Note sparing use of raw water. No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	8600					
Condensers and Cooling	some	8600	1740		120		0
Diffuser Supply		100%					
Lime Mud	X						

D. Waste Treatment

1. Flume and general waste screened, to 11 ponds, depth 8 ft. Days retention, total. No discharge. Clarifier - 100 ft. diam. to separate sand and dirt. Rubber lime pumps. They have 11 interconnected ponds - total area about 160 acres, but use only 3 ponds.
2. Lime mud to lime pond (lime pond and sludge pond) about 17 acres. No discharge.
3. Condenser water recycled through tower cooler. No discharge.
4. Sanitary sewer to septic tank.
5. Recycled portion of flume water screened and mud separated by mechanical clarifier (see D.1.).
6. Pulp and pulp press water 100% recycled to diffuser.

E. Comments: Holding ponds not cleaned (yet) - 100,000 cu. yds. in sludge ponds. Effluent discharged per ton beets sliced - 0. BOD discharged per ton beets - 0. No estimate given as to cost of waste treatment (author: $1 million, plus).

*Make up for losses to mud, evaporation and seepage.

WATER USE, RE-USE AND DISPOSAL

Maine Sugar Industries, Inc. at Easton, Maine

A. Beets sliced, tons/day:--4000; Total campaign:-- ca 350000; Gross raw water intake:--2000 (GPD x 10^3).

B. Flows sheet type II.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	500	Yes					
Condensers and Cooling	1200	Yes	150				
Diffuser Supply	300	Yes					
Lime Mud	0						

D. Waste Treatment (No report submitted. Meager information by telephone)

1. Flume and general waste screened, to ponds, originally two, now five; recycled to flumes. Have auxiliary mud pond. Elaborate system. Flume to clarifier, etc.
2. Condenser water to spray pond and recycled. Some used to thaw frozen beet cars, thence to flumes.
3. Diffuser supply: Pulp press water recycled, make-up with raw water.
4. Lime mud: Cake from drum filters puddled with little water, pumped (blown) to mud pond - no overflow.
5. Floor drainage (hose-down) to waste system. Sanitary sewage to septic tank.

E. Comments: Apparently little effluent or BOD to streams. Cost of waste treatment plant estimated at $5 million plus. This includes ponds, covered water storage, dump trucks, cranes (clam), piping, pumps, etc. Little odor problem, some at primary mud pond. Special problems: rocks to be separated and hauled away; freezing conditions. An integrated system - difficult to separate waste disposal from beet handling and water supply systems. Cost of operation (waste disposal) about $100,000 annually (their estimate). This plant processes raws from offshore. Also handles potatoes, hence more involved than the usual beet-house. An unusual feature: chlorination of small effluent flow.

WATER USE, RE-USE AND DISPOSAL

Michigan Sugar Company at Caro, Michigan

A. Beets sliced, tons/day:--1835; Total campaign:--280000; Gross water intake:--4450 (GPD x 10^3); Source: Cass River.

B. Flow sheet type II. Modifications: Raw water to flumes and diffuser together with recycle. Also raw water to lime mud. No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	1700	4300					
Condensers and Cooling	2400	0	0		250		
Diffuser Supply	250	250					
Lime Mud	100						

D. Waste Treatment

1. Flume and general waste screened, to settling pond (small) then to storage pond, 50 acres, 6 ft. deep. Retention - duration of campaign. Controlled outlet to Cass River; 76 lbs BOD/cu. ft./sec flow of river (state rules). When river is low none is discharged. Lime added to discharge from screen to hold pH at 12. Stops odors.
2. Lime mud ponded in two ponds, 8 acres total. No discharge.
3. Condenser water - 2150 discharged direct @ 45° C. (Temperature stream 9° C.)
4. Floor drains - 20 - to main sewer (to general ponds), 1500 lbs BOD per day. Gas washer to flumes. Chemical washes to main sewer.
5. Sanitary sewer to city sewage system.
6. Pulp and pulp press water recycled. (BMA tower diffuser)

E. Comments: Anticipate 20% increase in annual slice. Pollution problem will increase by 10%. Effluent per ton beets sliced 2300 gal.; BOD - 4 lbs per ton. Note: Stored wastes can be released during spring floods at a rate not exceeding 1% of river flow.

WATER USE, RE-USE AND DISPOSAL

Michigan Sugar Company at Croswell, Michigan

A. Beets sliced, tons/day:--1275; Total campaign:--208000; Gross water intake:--3250 (GPD x 10^3); Source: Black River. Nalco #918 added to water at factory. Cost about $2000 per year.

B. Flow sheet type II. Modifications: No Steffen. Raw water to sprays (flumes) and lime mud.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	75	2800					
Condensers and Cooling	3000		350		175		
Diffuser Supply	0	200					
Lime Mud	150						
Miscellaneous	25						

D. Waste Treatment

1. Flume and general waste screened, to holding ponds - (1) grit collector; mud to mud pond, 3 acres. Overflow to pond No. 2, 8 acres. Turbid overflow 0.8 mile to five ponds, 25 acres, to another pond near river, thence to Black River. Controlled flow, i.e., 5 lbs BOD/cu. ft. per second flow up river. Black River empties into St. Claire River.
2. Lime mud to ponds (2); overflow - 150 to general pond, containing 1500 lbs BOD/day.
3. Condenser water discharged direct - 1700+ (GPD x 10^3). Temperature 40° C.
4. Other wastes: 35-40 GPD x 10^3 containing 1000 lbs BOD per day discharged to general ponds. Also sanitary sewer, 10 GPD x 10^3 containing 50 lbs BOD/day to general ponds.
5. Pulp press water recycled 100%.

E. Comments: 2500 gal effluent discharged per ton beets; 4 lbs BOD per ton beets.

WATER USE, RE-USE AND DISPOSAL
Michigan Sugar Company at Sebewaing, Michigan

A. Beets sliced, tons/day:--1900; Total campaign:--about 300000; Gross water intake:--ca 4000 (GPD x 10^3).

B. Flow sheet type II. Modifications: Some raw water to flumes, diffuser and lime mud.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	1200	4000					
Condensers and Cooling	2450						
Diffuser Supply	250	100%					
Lime Mud	100						

Note: Questionnaire not returned. Above data rough estimate from information on visit.

D. Waste Treatment

1. Flumes and general waste screened, to clarifier, part recycled to flumes. Mud to mud pond. Overflow to recycle. Lime added before discharge to ponds (odor control). pH 8.5. Six ponds: #1-5.5 acres, #2-11.7 acres, #3-33 acres, #4-17.5 acres, #5-8.5 acres, #6-12.5 acres. Flow from #1 to #6 to ditch and the bay. Flow from #2-#3,#5,#6 may be diverted individually to ditch. Flow to bay controlled carefully. Must be no fish kill. When ice forms, flow to bay is stopped.
2. Lime mud to lime ponds: #1-33 acres or #2-5.9 acres. Overflow (supernatant) to settling pond #3-33 acres.
3. Pulp press water 100% recycled.

E. Comment: While there is no BOD standard, determinations are made regularly. Some odor problem.

WATER USE, RE-USE AND DISPOSAL

Michigan Sugar Company at Carrollton (Saginaw), Michigan

A. Beets sliced, tons/day:--1814; Total campaign:--293000; Gross water intake:--4600 (GPD x 10^3). Source: Saginaw River. Water treated with Nalco #918 at cold water tank. Cost $1650 per year.

B. Flow sheet type II. Modifications: Raw water to flume, diffuser supply and lime mud. Condenser water (86%) discharged direct. No Steffen.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	1650	3860					
Condensers and Cooling	2600	-			250		100
Diffuser Supply	250	125					
Lime Mud	100	-					

D. Waste Treatment

1. Flumes and general waste screened, to four ponds, 20 acres, 3-8 ft. deep. Retention 2 to 100 days. Discharged to river 1000 GPD x 10^3, containing 6000 BOD/day.
2. Lime mud to one pond, 17 acres. Overflow - 100 GPD x 10^3, to general ponds containing 2000 lbs BOD/day.
3. Condenser water - 2250 GPD x 10^3 discharged direct to river @ 45° C. BOD in condenser water 60 ppm.
4. Other wastes: Floor drainage - 20 GPD x 10^3 containing 1000 BOD per day to main sewer (general ponds); gas washer water to river (50 GPD x 10^3); chemical washes to ponds.
5. Sanitary sewer to city sewer system.
6. Pulp and pulp press water 100% recycled.

E. Comments: 30% increase in annual slice expected. Will provide, in future, complete recirculation of flume water. Also aerators for holding ponds. Note: Cost of cleaning mud and lime ponds per year $20,000. Lime added to flume pond to control odor. Effluent discharged 1800 gallons per ton beets; 3.5 lbs BOD/ton beets. Will be reduced 50% when planned changes are made.

WATER USE, RE-USE AND DISPOSAL

Monitor Sugar Company at Bay City, Michigan

A. Beets sliced, tons/day:--3500; Total campaign:--400-500000; Gross water intake:--8200 (GPD x 10^3); Source: Saginaw River.

B. Flow sheet type II. Modifications: Raw water to flumes. No Steffen. Excess condenser water discharged direct.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	3000	2000					
Condensers and Cooling	5000	0	800		1000		
Diffuser Supply	0	800					
Lime Mud	0						
Miscellaneous	200						

D. Waste Treatment

1. Flumes and general wastes screened (excellent), to holding facilities: 1 aerated lagoon 4.5 acres, 1 settling - 1 acre, 12 ft. deep. Discharged to river - 4000; BOD in waste 5-10,000 lbs per day.
2. Lime mud to four ponds, total area 15 acres. No overflow.
3. Condenser water, remainder discharged direct to river.
4. Pulp and pulp press water 100% recycled.
5. Other wastes: To main sewer and general ponds except acid washes which go to lime pond.

E. Comments: Aeration pond equipped with four 60 HP floating aerators. Nominal capacity 480 lbs O_2 per hour. State limitation on discharge to stream - 3550 lb BOD/day; settleable solids 35 ppm. This requirement is being met. Effluent per ton beets 1140 gal; BOD (maximum) 1 lb/ton.

WATER USE, RE-USE AND DISPOSAL

Northern Ohio Sugar Company (GWS Co.) at Fremont, Ohio

A. Beets sliced, tons/day:--1980; Total campaign:--320000; Gross water intake:--8650 from river (GPD x 10^3).

B. Flow sheet type II. Modifications: No Steffen. Ponds emptied when river is high. Condenser water to spray pond before discharge to river.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	7000					
Condensers and Cooling	8600				150		
Diffuser Supply	50	130					
Lime Mud	-						

D. Waste Treatment

1. Flumes and general wastes screened; to five settling channels, one holding pond, 2 acres. Retention time 12 hours, recycled 100%. Pond emptied in spring when river (Sandusky) is high at about 700 per day. BOD in this water in spring 7600 lb/day.
2. Lime mud discharged to one pond, 3 acres. Overflow (small) to general ponds.
3. Condenser water to spray pond for cooling and discharge, 8400 to river. Note: Previously, high temperature at discharge caused fish kill.
4. Other wastes: floor drainage 50; gas washer water 90; chemical washes all to flume water ponds.
5. Sanitary sewer to city sewage plant.
6. Pulp and pulp press water 100% recycled to diffuser.

E. Comments: Annual slice will be increased about 100,000 tons. Changes in waste treatment planned include: discharge from ponds to city sewage system. Also recycle condenser water after cooling. Cost of present waste treatment facilities $450,000. Annual operating costs $35,000. Volume effluent to stream 4200 gal/ton beets; 2.5 lb BOD/ton beets. Note: Five tons CaO per day added to flume water system to control odor. Cost of cleaning channels $0.50 per cu. yd.

WATER USE, RE-USE AND DISPOSAL

Northern Ohio Sugar Company (GWS Co.) at Findlay, Ohio

A. Beets sliced, tons/day:--1500; Total campaign:--245000; Gross water intake:--570 (GPD x 10^3); Source: 4 wells, but use only 2.

B. Flow sheet type IV. Modifications: None, completely closed system. Ponds ultimately emptied into City Sewage Plant.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes		6000					
Condensers and Cooling	520	6800	6620	6800			30
Diffuser Supply	50	250					
Lime Mud							

D. Waste Treatment

1. Flume and general waste screened, to three ponds, 5 acres, 4-6 ft. deep. Retention 1.5 days. Recycled to flumes. Ponds discharged to city sewage plant in spring - after BOD has been reduced - naturally, 60 GPD x 10^3 excess to city sewage. BOD to city sewer, average 10,000 lb/day.
2. Lime mud to lime pond, 2 acres. Overflow 30 to general ponds.
3. Condenser water to spray pond, cooled, returned to cold water tank.
4. Other wastes: floor drainage 50; gas washer water 90; chemical washes - all to flume pond.
5. Sanitary sewer to city sewage plant.
6. Pulp and pulp press water - 100% recycled.

E. Comment: Caustic soda added to flume water to hold pH up and to avoid odor. Cost of waste treatment facilities $300,000. Annual costs $30,000. No increase in slicing planned for future. Will install separate flume and condenser water systems. No effluent and no BOD discharged to streams. Accumulate yearly 11 x 10.6 gal. excess water, also 110,000 cu. ft. mud.

WATER USE, RE-USE AND DISPOSAL

Spreckels Sugar Company at Spreckels (Salinas), California

A. Beets sliced, tons/day:--6000; Total annually:--900000; Molasses worked, tons/day:--350; Total annually:--50000; Gross water intake:--9505* (GPD x 10^3); Source: Wells. Phosphate added to about 90%. Lime and resin treatment for that used in liquid sugar. Cost $2,000 - plant, $9,000 annually.

B. Flow sheet type III. Modifications: None.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	(1) 150	6000					
Condensers and Cooling	3310	10500	500		720		280
Diffuser Supply		1050					
Lime Mud							
Steffen	(2) 700						

D. Waste Treatment

1. Flume and general waste screened, to 11 ponds, 147 acres, 2-16 ft. deep. Only 500 to holding pond. Retained until **all** evaporated or percolated. No discharge.
2. Lime mud to ponds (6), 32 acres. Overflow--150-- to general ponds.
3. Condenser water cooled by tower and recycled - 3310 to ponds.
4. Steffen waste evaporated.
5. All other wastes, about 7000 to ponds, estimated BOD 4300 lb/day.
6. Pulp water 100% recycled.

E. Comments: Cost of facilities $700,000. Operating costs $15,000. Increase of 25% in annual slice expected.

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*Does not equal tabulated raw water use. The difference is primarily due to make up for water to muds, evaporation and seepage.

WATER USE, RE-USE AND DISPOSAL

Spreckels Sugar Company at Manteca, California

A. Beets sliced, tons/day:--4000; Total annually:--900000; Gross water intake:--6300* (GPD x 10^3); Source: Wells. Treatment of hot lime and soda to 2½% of total water.

B. Flow sheet type III. Modifications: Raw water to diffuser supply and to lime mud. No Steffen. No effluent to streams, only to ponds and irrigation.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	4500					
Condensers and Cooling	1750	4700	1600 (1)		500		180
Diffuser Supply	150	800					
Lime Mud	175						

(1) Beet washer and sprays

D. Waste Treatment

1. Flume and general wastes screened, to 15 ponds, 62 acres, 5-14 ft. deep. Retention 90 days. Discharged to irrigation - 4200 containing 5300 lbs BOD/day.
2. Lime mud to 8 ponds, 12 acres. Overflow - 290 to general ponds.
3. Condenser water to tower cooler and recycled.
4. Other wastes: floor drainage - 400 - containing 12,000 lbs sugar per day and chemical washes to general ponds. Gas washer water - 1000 - to lime pond and beet washer system.
5. Sanitary sewage to septic tank and ponds.
6. Pulp press water all recycled.

E. Comments: Oswald waste treatment, modified: from mud pond - anaerobic - aerobic (algae). Ten percent increase in annual slicing anticipated. Will add aerators to pond system. Cost of waste disposal system $200,000. Operating cost $20,000 per year. Effluent discharged to stream--none.

*Does not equal tabulated raw water use. The difference is primarily due to make up for water to muds, evaporation and seepage.

WATER USE, RE-USE AND DISPOSAL

Spreckels Sugar Company at Woodland, California

A. Beets sliced, tons/day:--3300; Total annually:--650000; Molasses worked, tons/day:--180; Total annually:--35000; Gross water intake:--6900 (GPD x 10^3); Pre-treatment: 90% with polyphosphate.

B. Flow sheet type III. Modifications: None.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	4100					
Condensers and Cooling	6900	6000	800	6000	300		
Diffuser Supply		500					
Lime Mud	0	0					
Steffen Dilution							

D. Waste Treatment

1. Flume and general waste screened, to 13 ponds, 442 acres (only half in use), 3 ft. deep. Retention 0-120 days. No discharge (evaporation and seepage).
2. Lime mud ponded, 11 acres, no overflow.
3. Condenser water cooled in tower and recycled.
4. Steffen waste all evaporated.
5. Other wastes: Floor drainage 2000 GPD containing 2000 lbs sugar, and chemical washes to main sewer; sanitary sewer to septic tank.

E. Comments: No effluent to streams. Replacement cost of waste treatment facilities $200,000, operating costs $15,000 per year.

WATER USE, RE-USE AND DISPOSAL
Spreckels Sugar Company at Mendota, California

A. Beets sliced, tons/day:--3900; Total annually:--900000; Molasses worked, tons/day:--220; Total annually:--45000; Gross water intake:--4132 (GPD x 10^3); Source: Wells. 2% treated with lime and resin for liquid sugar only. Cost $20,000 for plant, $2,500 per year.

B. Flow sheet type II. Modifications: Some raw water to flumes and to lime mud. Steffen waste to shallow ponds with no outlet (they dry up).

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Flows		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	1100	9000					
Condensers and Cooling	2500	7000	1100		450		40
Diffuser Supply	0	530					
Lime Mud	30						
Steffen	370						
Miscellaneous	132						

D. Waste Treatment

1. Flumes and general wastes screened, to nine ponds, total 160 acres, 4 ft. deep. Retention time - total. No discharge.
2. Lime mud to three ponds, 12 acres - 150 GPD x 10^3 - overflow to general ponds.
3. Condenser water to tower cooler and recycled.
4. Steffen waste to ponds (10), used alternately, total 47 acres. No discharge, loss by evaporation and seepage.
5. Other wastes: Floor drainage - 320 GPD x 10^3 containing 3500 lbs sugar per day to general ponds. Gas washer water - 350 GPD x 10^3 to waste water. Also chemical wastes. Sanitary sewer to septic tank.

E. Comments: Three of nine flume ponds, 24 acres, are sediment ponds. Cost of waste facilities $250,000, operating $20,000 per year. Effluent discharged per ton of beets - zero.

WATER USE, RE-USE AND DISPOSAL

Spreckels Sugar Company at Chandler, Arizona

A. Beets sliced, tons/day:--4000; Total annually:--650000; Gross water intake:--1883* (GPD x 10^3); Source: Wells. Treatment: one and one-half percent with lime and resin. Cost: $20,000 plant; $2,000 annual operation.

B. Flow sheet type III. Modifications: No Steffen. Raw water to lime mud - to lime pond with no overflow. No overflow from general ponds.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	6000					
Condensers and Cooling	1250	8000	760				
Diffuser Supply	0	750					
Lime Mud	33						

D. Waste Treatment

1. Flumes and general waste screened, to 7 ponds, 81 acres, 3-10 ft. deep. Retention - total. No discharge.
2. Lime mud to one pond, 3 acres. No overflow.
3. Condenser water to tower cooler, recycled. No direct discharge.
4. Pulp and pulp press water recycled to diffuser.
5. Other wastes: 240,000 gal/day containing 2200 lb BOD per day; to main sewer and ponds; gas washer water 190,000 gal; chemical washes to waste ponds. Sanitary sewer to septic tank.

E. Comments: Flume and general wastes: mud pond - aeration and circulation - digester - maturation ponds. Cost of waste disposal: Plant $450,000, Operation $20,000 per year. Additional aeration planned.

*Does not equal tabulated raw water use. The difference is primarily due to make up for water to muds, evaporation and seepage.

WATER USE, RE-USE AND DISPOSAL

Utah-Idaho Sugar Company at Garland, Utah

A. Beets sliced, tons/day:--2550; Total campaign:--315000; Molasses worked, tons/day:--110; Total campaign:--13000; Gross water intake:--8712 (GPD x 10^3); Source: River - 8640, Other - 72. Nalco softening; cost $1500/year.

B. Flow sheet type III. Modifications: Many. Raw water to diffuser as make-up. Condenser water discharged direct to river.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	7200					
Condenser and Cooling	8014	0		-			86
Diffuser Supply	288	648					
Lime Mud	86	-					
Steffen Dilution	180	-					
Miscellaneous	144					-	

D. Waste Treatment

1. Flumes and general wastes screened, to one desilting pond, 2.7 acres, 2 ft. deep. Retention time 6 days, recirculated to flumes. Enclosed system.
2. Lime mud to lime pond (1), 8.4 acres. Overflow to river. Actually most disappears by evaporation and seepage.
3. Condenser water - 8554 discharged direct to Malad River @ 55° C.
4. Steffen waste 100% evaporated CSF.
5. Other wastes: Gas washer water to flumes; others to main sewer (ponds). Sanitary sewer to city sewage plant.

E. Comments: No changes planned. Effluent discharged - 3350 gal per ton of beets. BOD discharged 4 lb/ton.

WATER USE, RE-USE AND DISPOSAL

Union Sugar Company at Betteravia, California

A. Beets sliced, tons/day:--4500-4800; Total annually:--1,106,000; Gross water intake:--3954 (GPD x 10^3); Source: Wells - pretreated (a) 98% with sodium hexameta phosphate, (b) 2% with zeolite softener. Cost of pretreatment: Initial $4500, annual cost: $19,700.

B. Flow sheet type III. Modifications: Raw water to diffuser supply (total) and miscellaneous. Pulp press water discharged to ocean by pulp drier contractor. No Steffen. No discharge from settling ponds or lime pond.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Lime Mud	Pulp Transpt.
Flumes	0	6432					
Condensers and Cooling	2246	9072	6864		1420	144	664
Diffuser Supply	1420	No					
Lime Mud	0						
Other	288						

D. Waste Treatment

1. Flume and general waste screened, to 3 ponds, 47 acres, 6 ft. deep, 10 days retention. Closed system - no discharge to stream.
2. Lime mud discharged to four ponds (used alternately) - 8,4,4, 6.4 acres. Overflow discharged direct - 144 GPD x 10^3.
3. Condenser water to spray pond - 9360 GPD x 10^3.
4. Other wastes: Floor drainage - 144; gas washer - 28; to main sewer. Chemical washes to lime pond. Sanitary sewer to septic tanks.
5. Pulp transported to Sinton and Brown dryer (200 yds.). Transport water recycled to Union Sugar pond system; press water discharges principally to ocean.

E. Comments: Annual accumulation of 6500 tons dirt. No discharge of effluent to stream - see 5 above. BOD in pulp press water to ocean by Sinton and Brown, probably 10-12 lbs per ton beets (estimated by author).

WATER USE, RE-USE AND DISPOSAL

Utah-Idaho Sugar Company at Idaho Falls, Idaho

A. Beets sliced, tons/day:--4200; Total annually:--595000; Molasses worked, tons/day:--125; Total annually:--21000; Gross water intake:--3600 (GPD x 10^3); Source: Wells. Treatment - Nalco to prevent scaling. Cost $500 per year.

B. Flow sheet type III. Modifications: Raw water to diffuser and lime mud. No overflow from lime pond. Full flume recirculation is planned for future.

C. In-Plant Water Flows (GPD x 10^3).

	Raw Water Use	Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	4320					
Condensers and Cooling	2542	5760	9360				
Diffuser Supply	648	936					
Lime Mud	86						
Steffen Dilution	180						
Miscellaneous	144						

D. Waste Treatment

1. Flume and general wastes screened, 4320 recycled, 3600 discharged direct to Snake River. BOD in waste to river - 16,000 lbs per day.
2. Lime mud to one pond, 6 acres. No overflow, no discharge.
3. Condenser water recycled through tower cooler to house. No discharge direct to stream.
4. Steffen waste 100% evaporated CSF.
5. Other wastes: Floor drainage - 14.4 GPD x 10^3 containing 69 lb BOD per day to sewer. Chemical washes to lime pond. Sanitary sewer - 200 GPD x 10^3 ; 34 lb BOD per day to septic tank and drain field.

E. Comments: After screening, mud partly removed by mechanical clarifier, partly by ponds. Increase of 16% in slicing planned. Cost of waste system $200,000. Annual cost $2000. Effluent to stream - 818 gal/ton beets. BOD 4 lb per ton.

WATER USE, RE-USE AND DISPOSAL

Utah-Idaho Sugar Company at West Jordan, Utah

A. Beets sliced, tons/day:--1600; Total campaign:--180000; Gross water intake:--7200 (GPD 10^3); Source: Wells - 1440, Jordan River, Nalco treatment for scaling control. Cost $1200/year.

B. Flow sheet type II. Modifications: No Steffen. Lime pond - no discharge.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes		0					
Condensers and Cooling	7000		6700		230		56
Diffuser Supply		1512					
Lime Mud	56						
Miscellaneous	144						

D. Waste Treatment

1. Flume and general waste screened, to one desilting pond, 2 acres, 2 ft. deep, 2 hours retention, to Bingham Creek to Jordan River - 7200 GPD x 10^3, containing 6800 lb BOD/day.
2. Lime mud to pond, 40 acres. No discharge.
3. Condenser water used in-plant flows. No direct discharge.
4. Other wastes: Floor drainage - 11,000 GPD (52 lbs BOD/day) to general wastes; gas washer water - 216,000 GPD to wastes. Chemical washes to lime pond. Sanitary sewer to city sewage plant (288,000 GPD - 28 lbs BOD/day).
5. Pulp press water recycled to diffuser.

E. Comments: Cost of waste plant $250,000. Annual operating cost $1,000. Effluent discharged to streams - 4325 gal/ton beets. BOD per ton - 4.0.

WATER USE, RE-USE AND DISPOSAL
Utah-Idaho Sugar Company at Toppenish, Washington

A. Beets sliced, tons/day:--3800; Total campaign:--495000; Gross water intake:--8640 (GPD x 10^3); Source: Wells. Nalco softening. $1500 per year.

B. Flow sheet type II. Modifications: No Steffen. Raw water to diffuser supply. No discharge from lime ponds or general ponds (seepage and evaporation). Condenser water direct to river.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condensers	Diffuser Supply	Steffen	Lime Mud
Flumes	0	7920					
Condenser and Cooling	7906	0	576				86
Diffuser Supply	518	1440					
Lime Mud	0						
Other	216						

D. Waste Treatment
1. Flume and general wastes screened, to one pond, 20 acres, 1 ft. deep. No discharge. Seepage and evaporation.
2. Lime mud to one pond, 20 acres. No overflow. Seepage and evaporation.
3. Condenser water - 7244 discharged direct to river @ temperature of 50° C.
4. Chemical washes to lime pond; sanitary sewer to septic tank - sewer.
5. Other wastes to main sewer.
6. Pulp water 100% recycled.

E. Comments: Cost of waste system $200,000. Annual operating costs $3000. Effluent discharged - 1906 gal. per ton beets, 4 lbs BOD per ton beets.

WATER USE, RE-USE AND DISPOSAL
Utah-Idaho Sugar Company at Moses Lake, Washington

A. Beets sliced, tons/day:--6450; Total annually:--900000; Molasses worked, tons/day:--225; Total annually:--38500; Gross water intake:--3715 (GPD x 10^3); Source: Wells.

B. Flow sheet type III. Modifications: Raw Water to diffuser make-up and lime mud. No discharge to stream. Seepage and evaporation. U-1 has 1200 acres land - use only 600 acres.

C. In-Plant Water Flows (GPD x 10^3).

Raw Water Use		Water Re-Use					
		Recycled	Flumes	Barometric Condenser	Diffuser Supply	Steffen	Lime Mud
Flumes	0	12009					
Condensers and Cooling	2225	10080	2880				
Diffuser Supply	922	1380					
Lime Mud	86						
Steffen Dilution	324						
Miscellaneous	158						

D. Waste Treatment

1. Flumes and general waste screened, to clarifier, to pond, 45 acres, 3 ft. deep. Recycled to flume. No discharge, seepage and evaporation.
2. Lime mud to one pond, 39 acres, no overflow.
3. Condenser water to three "Marley" cooling towers. Cools to about 20° C. - to main water tank (with well water).
4. Pulp and pulp press water recycled to diffuser.
5. Steffen waste all evaporated, added to beet pulp drier.
6. Other wastes: Floor drains - 14 GPD x 10^3 - BOD 69 lb. per day, to sewer; gas washer to sewer ponds (144 GPD x 10^3); chemical washes to lime pond; sanitary sewer to septic tank and drain field.

E. Comments: Increase of 60% in slice planned. Cost of waste plant $300,000, operating costs $2000. Effluent to stream per ton beets - zero. BOD to stream - zero.

QUESTIONNAIRE

State-of-Art, Sugarbeet Processing Waste Treatment
for the
Federal Water Quality Administration

Section A. General

1. Company Name ______________________________
2. Location of Plant ______________________________
   (City and State)
3. Typical dates of campaign, from __________ to __________
4. Annual beet tonnage processed __________
   Average 24-hour beet tonnage processed __________
5. If plant includes Steffen process:
   Annual tonnage of molasses processed __________
   Average tonnage molasses processed in 24 hours __________

Section B. Water Use (See Note)

1. Gross fresh water intake (1,000 gal/day) __________
2. Source of fresh (raw) water (1,000 gal/day) __________
   Wells _______ River or lake _______ Other _______
3. Is water treated before use? No _______ Yes _______
   (If yes, what percent of total is treated?) __________
   What types of treatment are provided:

   Estimated replacement cost of facilities to treat water before use: $__________
   Estimated annual operating cost of water treatment prior to use in the factory: $__________

Section C. Inplant Water Flows

1. Raw water use (1,000 gal/day):
   a. To flumes direct __________
   b. To barometric condensers and cooling __________
   c. To diffuser supply __________
   d. To lime mud __________
   e. To Steffen (dilution) __________
   f. Other __________
2. Flume water (1,000 gal/day):
   a. Total flow __________
   b. Recycled __________
   c. Discharged direct __________
   d. Discharged to ponds __________

Note: Data for 1968 campaign or latest completed campaign.

Section C. Inplant Water Flows (continued)

3. Barometric condenser and cooling water (1,000 gal/day):
    a. Total flow ____________
    b. Cooled and recycled ____________
    c. To flumes ____________
    d. To beet washers and sprays ____________
    e. To diffuser supply ____________
    f. To lime mud ____________
    g. Discharged direct ____________
    h. Other ____________
4. Pulp and pulp press water (1,000 gal/day):
    a. Total flow ____________
    b. Recycled to diffuser ____________
    c. Discharged to wastes ____________
    d. Other (explain) ____________

Section D. Waste Treatment

1. Flume and general waste:
    Screened - Yes ______ No ______
    Discharged direct ____________
    To holding facilities:
        Number of ponds ____________
        Acreage ____________
        Depth ____________
        Days retention ____________
        Discharged to ____________
        Volume discharged (1,000 gal/day) ____________
        BOD in waste discharged (lbs/day) ____________
2. Lime mud:
        Discharged direct - Yes ______ No ______
        Ponded - Yes ______ No ______
        Size and number of ponds ____________________________
        Overflow discharged - Yes ______ No ______
            Direct ____________ Volume (1,000 gal/day) ____________
            To general ponds ____________
        BOD in waste discharged (lbs/day) ____________
3. Condenser water:
        Discharged direct - Yes ______ No ______
        If condenser water is recycled, how is it cooled?
        Tower ______ Spray pond ______
        Volume discharged (1,000 gal/day) ____________
        Temperature ____________
4. Steffen waste:
        Discharged direct - Yes ______ No ______
        To ponds - Yes ______ No ______
        Evaporated - Yes ______ No ______
            (If yes, what percentage of total ____________)

Section D. Waste Treatment (continued)

5. Other wastes:
   a. Floor drainage:
      Discharged to main sewer - Yes _______ No _______
      Estimated average volume (1,000 gal/day) _______________
      Estimated average BOD lbs/day _______________
      lbs sugar/day _______________
   b. Gas washer discharge:
      Source of gas washer water _______________
      Discharged to _______________
      Estimated volume (1,000 gal/day) _______________
   c. Chemical washes:
      Boilout of pans and evaporators, discharged to ___________
      Estimated BOD (lbs/day) _______________
      Acid wash of filters, discharged to ______________
      Estimated BOD (lbs/day) _______________
   d. Sanitary Sewer:
      Estimated volume (1,000 gal/day) _______________
      Discharged to _______________
      Estimated BOD (lbs/day) _______________
6. Details:
   a. If flume and beet washer water are recycled, or partly recycled, what treatment, if any, is provided for the recycled portion: Screened _______ mud separated by mechanical clarifiers _______ by settling ponds _______ other _______
      Please show by sketch or diagram special features of treating system, including approximate dimensions or capacities.
   b. Is pulp and pulp press water completely recycled to diffuser? _______
      If not, what disposition is made of the excess?
   c. Are flume and general wastes treated in whole or in part by a biological system or process - Yes _______ No _______
      (If yes, show by sketch essential features; estimate effectiveness.)
   d. If a completely closed system, including integration with the condenser water system, is used (as in Findlay, Ohio), please estimate the quantity of surplus waste which accumulates annually. _______________

Section E. Special Information
1. What increase in annual slice of beets is anticipated during the period 1969 to 1979? _______________
2. What changes in waste treatment are anticipated during the period? _______________
3. Will an anticipated increase in the beet operations increase the water pollution problems and, if so, by how much? _______________

Section E. Special Information (continued)

4. Please estimate construction costs of waste water treatment facilities - $______________ Annual operating costs $__________
5. With existing waste disposal facilities, how many gallons of effluent is discharged to streams per ton of beets sliced? ______
   How many pounds BOD per ton of beets sliced - (Your best estimate is requested). ______________
   How much can these quantities be reduced by contemplated changes in waste disposal facilities? ______________

Section F. Remarks and Comments

1 *Accession Number* **W**	2 *Subject Field & Group* 05D	**SELECTED WATER RESOURCES ABSTRACTS** **INPUT TRANSACTION FORM**

5 *Organization*

Beet Sugar Development Foundation, P.O. Box 538 Fort Collins, Colorado 20521

6 *Title*

State-Of-Art, Sugarbeet Processing Waste Treatment

10 *Author(s)* Fischer, James A. Hungerford, Edgar H.	16 *Project Designation* EPA, WQO Contract 12060 DSI 07/71 21 *Note* N/A

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Sugarbeet waste treatment*, SB Waste Treatment Technology State-of-the-Art*, Water Consumption*, Treatment Costs*

27 *Abstract*

The beet sugar industry in the United States produces annually more than 3 million tons of sugar from about 25 million tons of beets grown in 19 states. This paper reports the waste disposal practices of the 58 beet sugar factories operating in 1968-69 and provides an estimate of the amount of pollution of streams attributable to these factories. It is shown that, although stream pollution has been greatly reduced, the beet industry still discharges to streams 3.15 pounds BOD per ton of beets sliced or a total of about 79 million pounds annually. Amounts of water used are reported and methods of re-use of water described. Estimates of total settleable solids are made; methods of elimination are described. Effectiveness of some biological treatments are estimated. Needed research is briefly outlined. Costs of waste disposal facilities and annual operating costs are shown for many of the plants. A brief description of the beet sugar process is furnished. Current practices employed by a selected group of sugarbeet processing plants in several Western European countries are also described.

Abstractor Fischer, James A.	*Institution* Beet Sugar Development Foundation Fort Collins, Colorado

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